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Melting Changes Bring Lower Costs

Open-hearth Displaced Electric Furnace in a Steel Foundry When Power Charges Became Excessive—Converters Will Be Used as an Adjunct to Increase Production When Needed

EXACT methods of cost finding and proper interpretation of results obtained through cost investigation are more than ever imperative. The foundryman cannot afford to grope in the dark and trust to luck in these days of mounting material and labor prices. Accurate knowledge of costs in all departments alone can enable the manufacturer to maintain selling prices which will show profit. The melting department too often is not considered carefully enough when production costs are studied. Many foundrymen, with their attention focused on the first cost of an installation in use are blind to the continued loss incident to operation, and loath to make changes. Local conditions arising after equipment is installed often prevent economical operation of a melting unit. If costs are accurately known this condition at once will be apparent and changes can be made which repair the loss without delay. The wisdom of this course is exemplified at the plant of the Bayonne Steel Castings Co., Bayonne, N. J. This company has changed its melting equipment, not once, but several times to avail itself of the advantage of diverse circumstances. The foundry was started as a converter shop. Later the original cupolas which melted the iron were modified to burn oil together with coke in melting. This modification was made under the direction of the Stoughton Process Corp., New York. The use of oil assisted in keeping the percentage of sulphur low in the iron because less coke was needed for melting. However,, during the war the coke which the company received was poor quality and contained such a large amount of sulphur that difficulty was experienced in meeting the customers' specifications for castings. On this account, it was decided to install an electric furnace. A 3-ton furnace of the heroult type was erected and put into operation. This furnace made a good grade of steel but an increased price for power made the operating expense excessive. When the power charges reached nearly 2 cents a kilowatt hour it was decided to sell the electric furnace and install an open-hearth furnace. Accordingly,

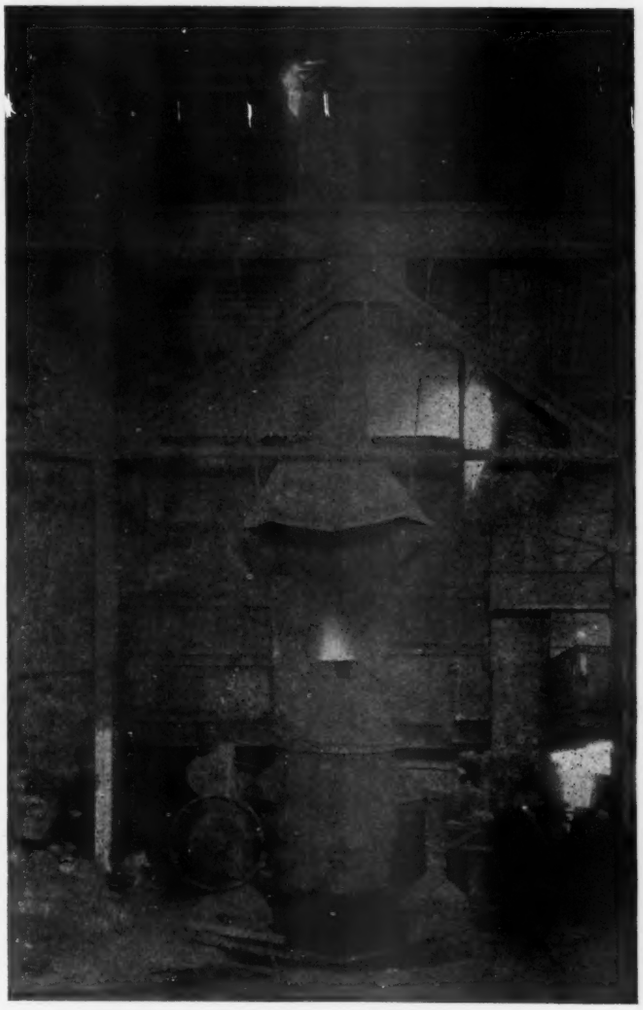


FIG. 1—OIL IS USED WITH COKE IN MELTING METAL FOR THE CONVERTERS—RECARBURIZERS ARE MELTED IN THE SMALL CUPOLA TO THE RIGHT

FIG. 2—COVER CORES ARE MADE SO THAT THEY WILL FORM A CIRCLE OF ALMOST ANY DIAMETER—THIS IS ACCOMPLISHED BY THE WAY ONE CORE FITS INTO ANOTHER—A HOLE FOR POURING THE METAL THROUGH IS MADE IN AN OCCASIONAL CORE

a 6-ton open-hearth furnace was secured from Holcroft & Co., Detroit, and with the converters now comprises the equipment of the plant. This furnace is acid lined. It has been in operation only a short time but experience has shown the company that six heats can be taken from the furnace in 24 hours. This output, with 12 blows of the converter will supply the metal demands incident to the present molding capacity of the shop. The company believes that the open-hearth furnace produces steel which is satisfactory in quality for all their requirements and at a less cost than was possible with the electric furnace. The main item of expense on the electric furnace was power. Current was obtained from the public service corporation figured on a sliding scale based on consumption. The last month the electric furnace was operated a charge of 1.97 cents per kilowatt hour was made.

A view of the pouring side of the open-hearth furnace is shown in Fig. 6. This illustrates the method of removing

FIG. 3—A CORE BOX AND A SWEEP, WITH A SCRIBING BOARD WERE ALL THE PATTERN EQUIPMENT NEEDED FOR MAKING THIS MOLD—STANDARD COVER CORES SHOWN IN FIG. 2 WERE USED

the pouring spout after a heat is tapped. The spout is attached to a chain block which hooks to four eyes, two on each side of the spout. After the spout is raised, it is carried to the end of the furnace on a trolley, suspended from an I-beam. The workmen then may repair the tap hole of the furnace, free from interference of the spout.

At present metal is tapped from the open hearth into a 6-ton bottom-pour ladle. A cold manganese addition is added in the ladle. It is thought that the metal from this furnace can be obtained hot enough to pour over the lip, and 2-ton ladles are to be secured in the future with this end in view.

The 2-ton converters and three cupolas are situated in one end of the bay in which the open-hearth furnace is placed but at the opposite end. One of the cupolas is lined to 36 inches and another to 34 inches. The third cupola is a small one used to melt the manganese recarburizers. This small cupola with one of the converters is shown in Fig. 1. Four 2 x 12-inch tuyeres are provided on the 36-inch cupola which is used the most frequently. These have been placed slightly lower in the cupola than they were originally.

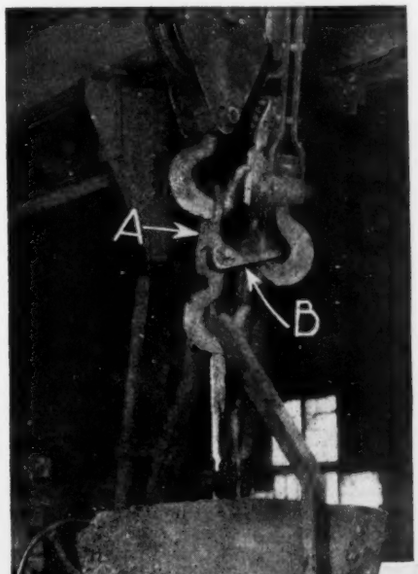
Before the change in the cupola and the introduction of oil, the melting ratio between charges was 6 of iron to 1 of coke. Now a ratio of less than 10 to 1 gives excellent results

The saving of coke in melting, to some extent is balanced by the use of from 4 to 6 gallons of oil to a ton of metal melted. However, much less sulphur is taken up by the metal in melting with oil. The company estimates that on an average the sulphur content of the steel is from 0.02 to 0.03 per cent lower using oil fuel than it would be if the cupola charge still were melted with the coke ratio of 6 to 1. This ratio, which may seem high to gray-iron foundrymen, was necessary because of the great amount of steel scrap in the charge. Of 1200 pounds of metal on the charge, from 500 to 600 pounds is scrap steel and the remainder is pig iron. When special metal which requires unusually low sulphur is to be made, less coke is placed between some of the charges. The amount of coke between charges has been lowered to 75 pounds for two or three charges and the heat of the resulting metal has been high enough for blowing in the converter.

The changes which were made in the tuyeres to adapt the cupola for burning oil also have proved beneficial when oil is not used. It has been found that iron can be melted with coke alone at a higher ratio than 6 to 1 in the remodeled cupola. Indications also point to still further reducing the amount of coke used when burning oil as a fuel in junction with it.

As has been mentioned, the converters are in one end of a bay of the foundry and the open-hearth furnace is in the other end of the same bay. The space between them is used for molding. The center aisle is devoted to molding and the bay on the opposite side of the foundry is occupied by the annealing furnace, the core room and the cleaning, finishing and shipping department.

Cranes run the length of the shop in all of these sections. In the main bay two cranes, one 10-ton and the other 5-ton, built by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., serve all molding operations in this section. Two 5-ton cranes supplied by the Shaw Crane Works of Manning, Maxwell & Moore, Inc., New York.



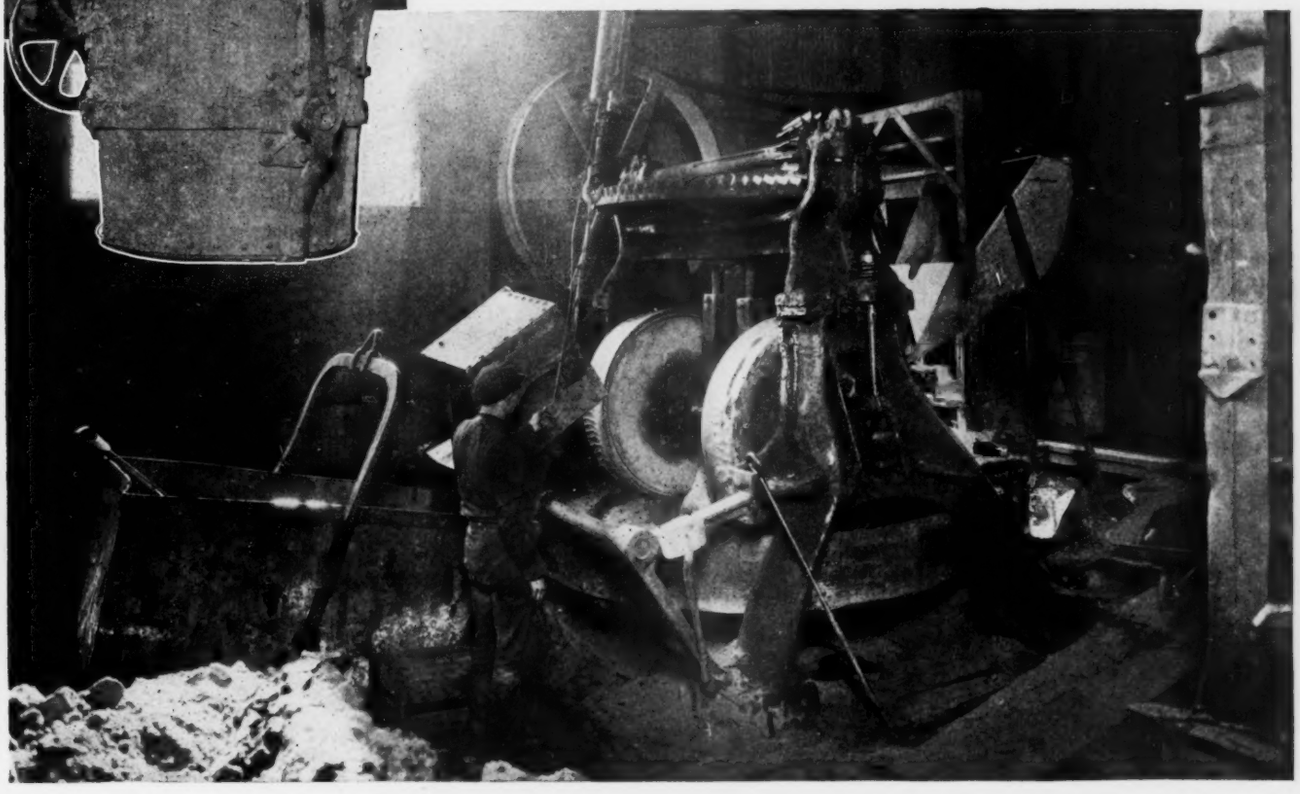


FIG. 4—TWO EYES TO THE CRANE HOOK SIMPLIFY TRANSFERENCE OF LADLES FROM ONE CRANE TO ANOTHER
FIG. 5—A LOADER WHICH DUMPS THE SAND INTO THE MIXER AND AN UNLOADER WHICH SCRAPES THE SAND FROM THE BOTTOM OF THE MIXER AND DUMPS IT INTO BUCKETS, REDUCES MANUAL LABOR

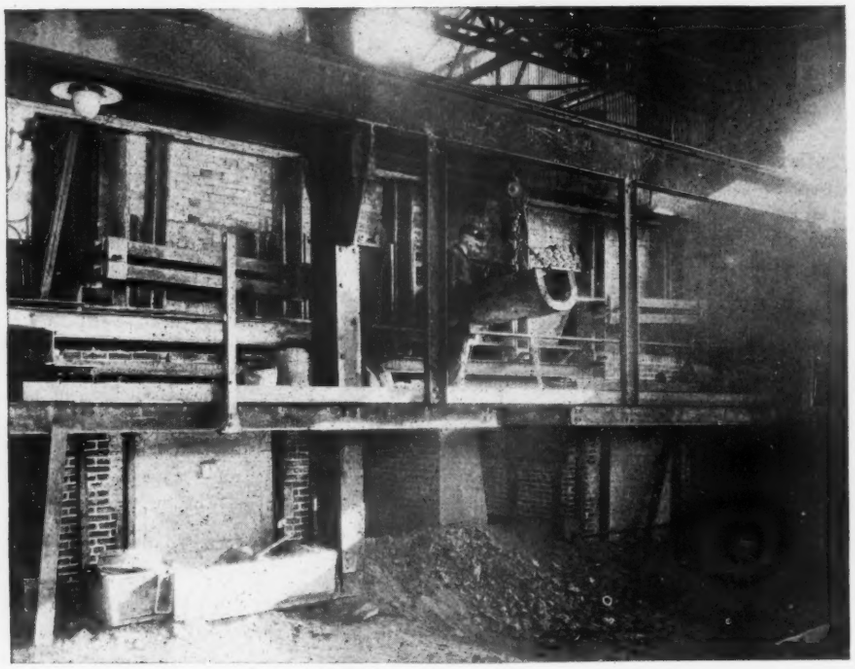


FIG. 6—THE POURING SPOUT IS CARRIED AWAY WITH A CHAIN HOIST ATTACHED TO A TROLLEY SUPPORTED ON AN I BEAM, BEFORE MENDING THE TAP HOLE

serve the molding floor between the converters and the open hearth. The section on the opposite side of the foundry, which contains the shipping and finishing departments is provided with two 3½-ton cranes. One of these was supplied by Pauling & Harnischfeger, Milwaukee, and the other by the Shepard company. Frequently each of the latter cranes is burdened with 5-ton loads. As they both have a 100 per cent overload rating, this may be done without injuring the cranes. In addition to the cranes in the building a system of monorails extends over the stock yard and across the charging floors of the cupolas and the open-hearth furnace. Two electric hoists of 1 and 2 tons capacity, respectively, are carried by trolleys on I-beams. Each trolley also is provided with a cage for the operator. The hoists were manufactured by the Sprague Electric Works of the General Electric Co., New York. Materials are carried from the stock piles in steel buckets and dumped on the charging platform. Both the cupolas and the open-hearth furnace at present are hand charged.

All metal from the furnaces is poured into ladles held by the cranes in the center bay. To pour the molds in the section between the converters and the open-hearth furnace, ladles must be transferred to the crane in the section which runs parallel to the main bay. Formerly the crane in the main bay set the ladle of steel on the floor at a point covered by a small hand-operated swinging jib crane. The ladle was then raised from the floor by a 6-ton chain block hoist held by the jib crane and swung into the other bay. Here the ladle again was set on the floor. From this point it was picked up and carried to the molds by a traveling crane.

Double Hook for Transferring Ladles

John Paldauf, the foreman of the cleaning room observed the time wasted in this transfer and planned the rig shown in Fig. 4. This is simply a hook connected with two eye-pieces by a pin on which the eye-pieces are free to swing. As shown in the illustration the crane in the main bay holds the ladle by the eye, *A*, while the hook of jib crane is attached to the eye, *B*. For transferring the ladle the hook on the traveling crane is lowered. This gradually puts the weight of the ladle on the jib crane. When all the weight is off the traveling crane its hook is removed and the jib crane is free to swing the ladle into the other bay. Here it is transferred to one of the traveling cranes by the same method as was used to hang it on the jib crane.

Three core and mold drying ovens are situated just off the main section and near enough so that the crane in this bay can lift the molds onto racks, one of which is shown at *C*, Fig. 3. These racks are run into the ovens by lift trucks from the Lewis-Shepard Co., Boston. One of the methods for handling the smaller molds is shown in Fig. 8.

The molds shown in the foreground have been made on the frames upon which they rest. The production clerk standing on the frame is placing an asbestos tag on the mold. This tag is marked with the pattern number of the castings in the mold, the number of castings on the gate and the date the mold is to be cast. Its functions will be explained later in this article.

The drying ovens were built by Holcroft & Co., Detroit. Each of them is 13 feet deep and 7 feet high. Two are 6 feet wide and the other is 12 feet wide. They are oil burning and are equipped with two fans, one for forced draft and the other to exhaust the moisture laden air from the molds and cores. A recording thermometer is attached to each oven.

A novel cover core used by this company is shown in Fig. 2. All of these cores are the same size but a certain number of them are made with holes as shown at *A*. These holes form gates or cups for pouring the metal, or for risers which can be formed with a built-up cup in the usual manner. These

FIG. 7—THE ANNEALING-OVEN CAR IS MOVED BY THE CRANE WHICH HOOKS TO IT THROUGH A SNATCH BLOCK LOCATED IN THE FLOOR AT EITHER END OF THE OVEN

FIG. 8—PIECES OF ASBESTOS ARE USED TO MARK THE MOLDS WITH THE PATTERN NUMBER, THE NUMBER OF CASTINGS ON THE GATE AND THE DATE OF CASTING

cover cores are so designed that they can be arranged in curves with different radii as may be seen from the illustration. The rounded end of one core fits into the indented end of the next core and by turning the cores slightly, the radius of the curve formed will be increased or shortened. The manner of using these cores is illustrated in Fig. 3.

Simplify Molding Operations

The casting to be made from the mold shown is a round ring with a flange. A section may be seen between the central section of the mold and the core which is in place. Only one casting was wanted. Therefore, it was desired to make the mold without a pattern. To accomplish this a rather novel method was adopted. A wooden flask was rammed with sand by the use of a pneumatic rammer. A spindle was set in the middle and a rectangular brace was laid around the spindle at the top of the mold as shown at *A*. This brace supported the sweep as it swung around the circle. After the sand was rammed in the flask the latter was removed and sand was cut away so that the sweep could be placed. The cylindrical center or green sand core then was formed by the sweep and nails were embedded in the face of the mold to strengthen it. After this was skin dried the cores were assembled around the circle as indicated by the one in place in the illustration. The box for this core was the only equipment which had to be made for this job, other than the sweep and the simple board with a hole in one end, shown at *B*. This scribing board was used to make the circle which gave the distance for cutting away the sand before sweeping the mold. When the side cores were set the cover cores were put in place as shown. Then a flask was laid around the entire mold and sand rammed between the flask and the sides of the mold. Finally the top cores were weighted down and two pouring cups were placed, so that the casting could be poured from opposite sides with two ladles.

Preparing the Sand

Molding sand is ground in a muller-type mixer as shown in Fig. 5. This is fitted with a loader and an unloader which permit the operation to be carried out with the least possible manual labor. The loader which may be seen to the right, was built by the Chain Belt Co., Milwaukee. The pan which is shown dumping sand into the mixer is raised by a steel cable attached to a drum on a shaft on the framework at the front. The unloader is dropped upon the floor of the mixing pan, where it is auto-

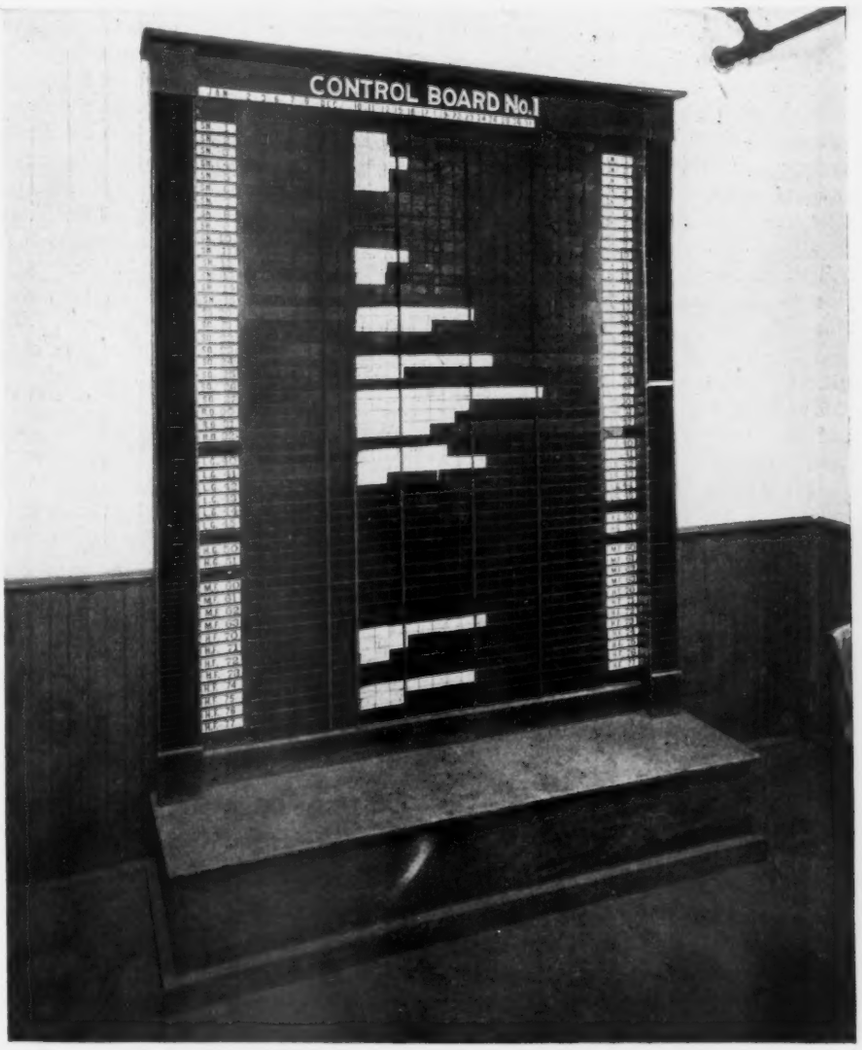


FIG. 9—THE CONTROL BOARD FORMS THE CENTER OF A COMPLETE PRODUCTION SYSTEM—THE FLOORS ON WHICH THE JOBS ARE MOLDED ARE INDICATED BY THE ROWS OF WHITE CARDS ON EITHER SIDE OF THE BOARD

matically filled with the sand it scrapes from the floor of the pan as the latter revolves. It then is lifted by the pneumatic hoist above it and dumps its load of sand into a bucket which is carried to molding floor by one of the traveling cranes. This unloader was made by the Frost Mfg. Co., Galesburg, Ill. Core sand is treated in a mixer made by the Blystone Mfg. Co., Cambridge Springs, Pa.

Many of the castings are annealed and care is taken in this operation to see that the correct temperature is maintained. Both an indicating and a recording pyrometer are used. The indicator is placed near the furnace, but the recording instrument is mounted in the laboratory where the metallurgist in charge can keep in touch with the heat record. The furnace is shown in Fig. 7 with a carload of castings which have just been removed. Cars are pulled in or out of the furnace by the crane. To do this the hook of the crane is attached to the eye of a steel cable which is passed through a snatch block on the floor at some distance from the furnace at either end and attached to the car. The two oil burners are shown to the right.

Metallurgical supervision is maintained over all steelmaking operations. A chemical and physical laboratory has been equipped for testing the raw materials and the finished steel. No preliminary tests are made of the open-hearth steel as all of it is low or medium carbon and the melter can gage the carbon content by the fracture of a test piece. However, every finished heat of open-hearth steel is analyzed for carbon, silicon, manganese, sulphur and phosphorus. On account of the smaller size and the greater number of converter heats a complete analysis is not made of every blow but carbon, manganese and silicon are determined in each heat to assure that the steel is uniform. Nearly all the carbon is blown out of the steel in the converter and then enough carbon is added to bring the carbon content of the steel to the required amount. This gives results close to those desired. In addition to chemical and physical tests to which the steel is subjected, it frequently is examined microscopically to study its structure.

Comprehensive Control System

Recently a complete production system was installed as laid out by C. E. Knoeppel & Co., New York. The central feature of this system is the control board shown in Fig. 9. At the top of this board is a row of movable figures indicating the date. On each side is a column of white cards containing the numbers of the molding floors with letters to designate the class of work done on each floor. *SN* at the top means snap flask; *SQ*, the next, stands for squeeze; *RO* indicates that a rollover machine is on that particular floor; *LG* and *HG* means that the molds are made in light and heavy green sand respectively; and *MF* or *HF* indicate that the molds will be made on the floor and are medium or heavy according whether *M* or *H* is marked. At each of the extreme edges a column protrudes from the board. On the inside of each of these columns is a yellow card bearing the number of the molder working on the job. This side may be seen on the column at the right of the board.

The white lines near the center of the board are made by record cards which have been placed in slots in the board for holding them. On various columns full information regarding the job may be put in different sections of the card. Two of these cards are filled out in duplicate when the order is received. One is sent to the control board for record and the other is delivered to pattern storage where it is put on the pattern. It goes with the pattern to the foundry and the foundry clerk gets all the information he needs from it. After the required information is recorded in the molding clerk's book, the ticket is sent to the control board. From the data the clerk gets from this ticket he is enabled to fill out the asbestos tags previously mentioned. These tags are made by tearing sheet asbestos. A tag is placed on every mold when it is made, as shown in Fig. 8, and removed just before the mold is to be cast. The tags then afford a record of all the castings made from any heat.

All assets and liabilities of the Pasteur-Chamberland Filter Co., Squier Filter Co. and the Dayton Water Motor Co. have been taken over by the American Mfg. Co., Dayton, O., which was recently incorporated with $100,000 capital. The company will continue the manufacture of washing machines and will also engage in a general manufacturing business consisting of brass and aluminum castings, polishing and plating, metal spinning and general tool and machine work. Officers of the new company are: President and treasurer, A. B. Hilton Jr.; vice president, J. H. Hosstetter, and secretary, Joseph W. Green.

The Blaw-Knox Co., Pittsburgh, has purchased the C. D. Pruden Co., Baltimore, which operated a plant manufacturing standardized steel buildings, for industrial and warehouse purposes, cottages and garages and will operate it as part of its already extensive plant and equipment.

Foundrymen Here Talk on Furnace Linings

The fusion point of refractories must not be taken at its face value in determining the working properties of different classes of furnace linings, according to Raymond M. Howe, of the Mellon Institute of Industrial Research, Pittsburgh, who spoke Wednseday night, March 10, before the New England Foundrymen's association. Mr. Howe's subject was refractories, and his talk which was profusely illustrated with slides, outlined and described in considerable detail the lining and manufacture of fire clay, silica and magnesite bricks. High grade fire clay bricks fuse at about 3200 degrees Fahr. but soften considerably below this point. Silica brick, on the other hand, fuse at about 3150 degrees Fahr. but keep their shape and strength to a temperature close to this point and therefore will hold up under many classes of work, better than the fire clay. Magnesite brick fuses at temperatures from 4000 to 4500 degrees Fahr. but commences to soften at about 3100. Both silica and magnesite brick spall away under quick change of temperature so that their use is limited to classes of work such as open-hearth furnaces where the temperature can be raised over an extended period of time. The question of mortar for use in laying up bricks is one that has given furnace builders and operators a great deal of trouble. Poor fire clay does not set up well and also is likely to crack in cooling. Portland cement and lime have been tried, but even as small as 5 or 6 per cent of these ingredients will greatly reduce the fusion temperature of the mortar as a whole. The Mellon institute has tested mortars made up of a great variety of substances, but has found nothing which is better than a mixture of 50 per cent high grade fire clay and 50 per cent finely ground bats. Such a mixture works fairly well, adheres to the brick, has a high fusion point, and does not crack.

Will Use Akron Laboratory

Arrangements have been made between the Courtney-Fraser Co., of New York, and the Charles C. Kawin Co., of Chicago, whereby the laboratory of the former at Akron, O., will be operated as a branch of the Charles C. Kawin Co. The Courtney-Fraser Co. has arranged to have the business of its laboratory at Buffalo cared for at Buffalo laboratory of the Charles C. Kawin Co. Both Mr. Courtney and Mr. Frazer have retired from the business and will have no further active connection with it.

Manufacturing Chilled Iron Car Wheels - I

How the Industry Faced Competition and Won Through the Application of Metallurgy

BY H. E. DILLER

MILLIONS of wheels—cast-steel wheels with hardened treads, steel-tired wheels, rolled-steel wheels, chilled iron wheels—continually are rolling over thousands of miles of parallel threads of steel, bearing the burden of commerce to every corner of the civilized world. Locomotives, passenger coaches and freight cars all are borne on wheels, either of steel or iron, and great is the danger if one of these many millions of wheels proves defective, throwing a car from the track as it speeds along. This element makes the engineer cautious. He seeks to specify the kind of wheel least likely to fail under strenuous service. The cheapest of all wheels is the chilled iron wheel and approximately 95 per cent of all freight cars are equipped with chilled-iron wheels. Chilled wheels are also used to some extent on passenger cars in suburban service, refrigerator cars, engine tenders, city and interurban, electric cars, electric locomotives and on mine cars. On freight cars alone there are 20,000,000 chilled iron wheels in service in the United States and Canada and this number would be greatly augmented if the chilled wheels in all sorts of service were counted.

The chilled iron car wheel primarily is an American product, but during the war Europe became familiar with the chilled iron car wheel through large numbers of freight cars which were sent to France, Italy and Russia. The standard wheel in America has a 33-inch diameter regardless of the wheel weight, and the heaviest made is the 850-pound type which is used on cars with a maximum gross weight of 210,000 pounds. Considerably larger wheels have been made for the European countries. One wheel made for the Italian government was 39 inches in diameter and weighed 925 pounds. This was used on a car of 40,000 pounds capacity. However, the car had only four wheels as compared to the American car with eight wheels. Even allowing for this difference, the weight of wheel to weight of car was much larger for the Italian car.

The chilled iron wheel was first introduced about 1835 and it came into general use about 1850, after Asa Whitney discovered the advantage to be obtained from annealing or *pitting* the wheels. This process was patented by him in 1847. At this time, a number of patents were taken out by different inventors covering the design of the wheel and methods of chilling the tread. Since then, the chilled iron wheel has continued in general use and its method of manufacture has followed the same basic lines. While a number of new style, cast wheels later have been brought on the market, only one has succeeded to a marked extent. This is the cast-steel wheel produced with a tread of hardened manganese steel. To secure this tread, it is the practice to revolve the mold and start pouring. At the same time powdered ferromanganese is introduced into the first metal that flows into the mold. This makes a manganese steel which is forced to the periphery by the centrifugal action of the revolving mold. The stream of ferromanganese is cut off after a certain amount of steel has passed into the mold and the remainder of the mold is filled with untreated steel which is softer and more malleable than the rim. It is necessary to harden the tread of this wheel to secure the most efficient wearing qualities. This is done by reheating the wheels in a furnace and then placing them in a tempering machine where water is sprayed on the flange and tread to harden them.

The chilled iron wheel holds its pre-eminent position due to its service and low cost. Foundry capacity for these wheels amounts to 20,000 wheels a day, or approximately 6,000,000 wheels a year. When it is figured that two molders or a molder and a helper make 25 wheels a day it will be seen that 800 molders would be required to meet the full chilled wheel requirements. The chilled iron wheel consists of a hard tread, connected to a soft plate by an interlacing of the chilled structure with the gray-iron of the plate, and a soft hub on which the axle can be pressed without endangering the quality of the wheel. The tread and flange which wear against the rail are chilled to a depth of ½ to ¾-inch and the resultant white iron with approximately 3.5 per cent carbon is of intense hardness. The wearing surface of the wheel is harder than the rail on which the wheel travels and will sustain any load the rail will carry.

The effect of any wheel on the rail and the brake shoe is an important item for consideration. Some manufacturers of car wheels assert that the chilled iron wheel has a greater coefficient of friction than any rolled or forged material when in contact with the brake shoe. The claim also is made that the chilled iron wheel has

THAT chilled iron car wheels are made in enormous quantities is realized by everyone in the least familiar with the railroads and their operation. However, the importance of this great branch of the foundry industry perhaps is not appreciated even by many castings manufacturers. Approximately one-seventh of the pig iron used in gray-iron foundries of this country is melted to make chilled iron car wheels. In this and a series of articles which follow, the history, metallurgy, molding, testing and inspection of this important foundry product will be discussed. The next installment will appear April 15.

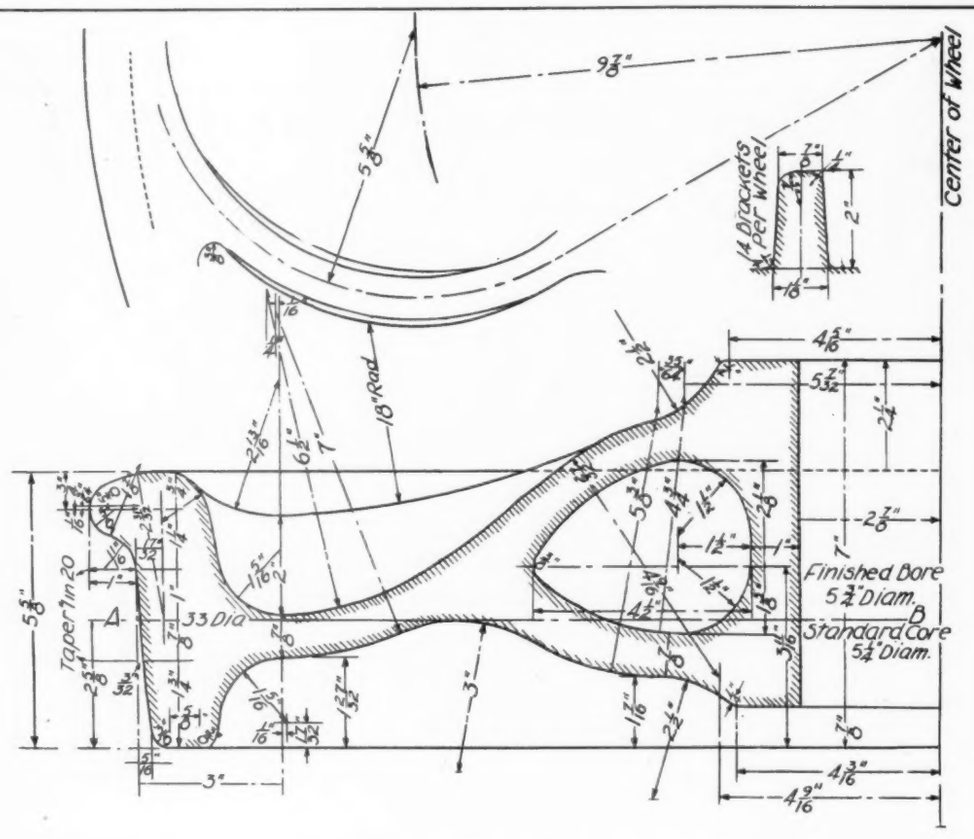


FIG. 1—CAST-IRON, 33-INCH WHEEL FOR CARS OF MAXIMUM GROSS WEIGHT NOT EXCEEDING 95,000 POUNDS—NOTE THE DOUBLE CURVE IN THE FRONT SIDE OF THE WHEEL, FACING DOWN IN THE ILLUSTRATION

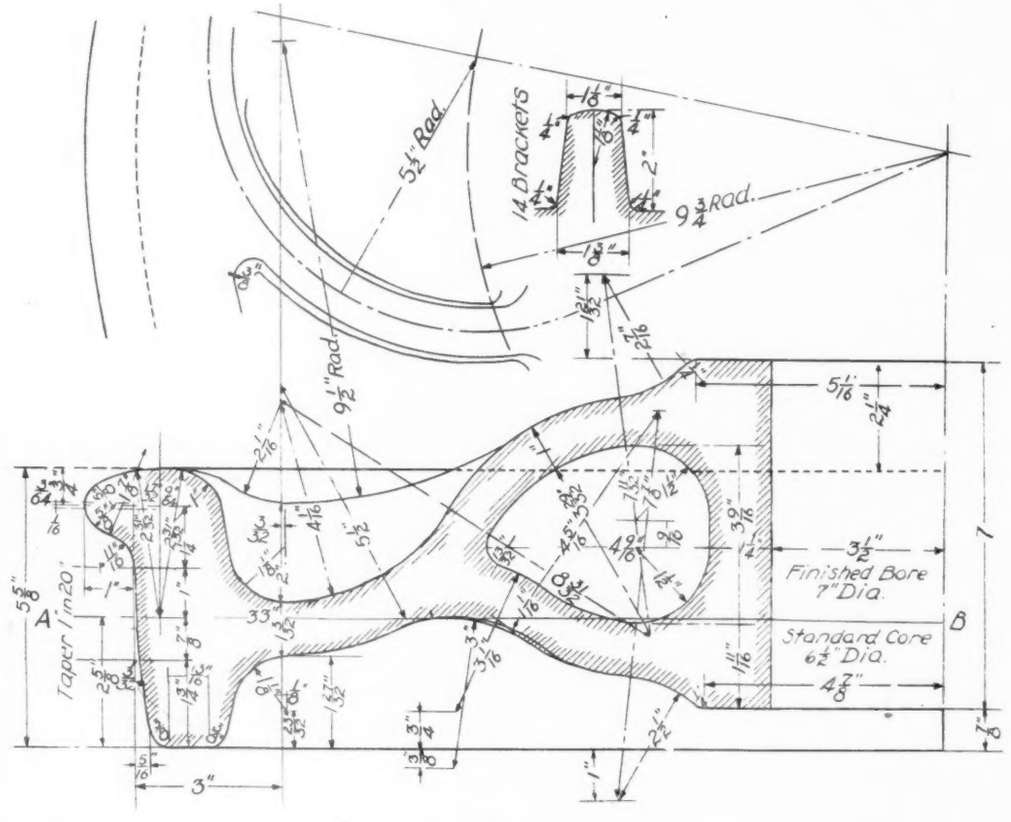


FIG. 2—CAST-IRON, 33-INCH WHEEL FOR CARS OF MAXIMUM GROSS WEIGHT NOT EXCEEDING 161,000 POUNDS—THIS IS SIMILAR IN DESIGN TO THE WHEEL SHOWN IN FIG. 1, BUT WITH ENLARGED SECTIONS

25 per cent greater retarding pressure under the same shoe pressure than any rolled or forged material now used for car wheels. The fact that the tread of the wheel has a smooth surface which prolongs the life of the brake shoe, is used to support the claim that it is less destructive to the rail than other kind of wheels.

Sponsors for the Wheel

Chilled iron wheel manufacture owes much to the work of two organizations which have sought to perfect and standardize the wheel. The Master Car Builders' association which was organized in 1867 since that time has acted as a referee or judge of materials for car construction. After a material or design has proved its merit the Master Car Builders' association adopts it as *recommended practice* and it becomes a standard. All such recommended practices are spoken of as M. C. B. standards. The railroads follow these standards in the main, although some of the railroads have specifications which differ in certain points because the engineer in charge feels he has definite proof that designs according to his ideas have given better service than the recommended practice. However, the recommended practice of the master car builders generally is followed closely by the railroads in making their specification.

This organization of master car builders was merged with the body representing the master mechanics into a section of the American Railroad association, after the government took control of the railroads. Thus the two organizations, the one which standardizes the cars and the other which standardizes the locomotives are joined into the same organization. Whether they will remain together now that the roads have been returned to private control is open to supposition.

About 1900 the reputation of the chilled car wheel was open to question and some railroads were considering the adoption of the steel tired wheel for freight cars to insure safety for their traffic. This was because some of the manufacturers were not making as high grade wheel as they should. At the time little was known of the metallurgy of cast iron and the manufacturer of car wheels, to a large extent, was groping in the dark. Some of the car wheel companies introduced chemical control, but it was necessary for the chemist to learn many things about iron and car wheels before he could be of any measureable service. Drawn together by a desire to raise the standard of the chilled iron car wheel, the manufacturers in 1908 organized the Association of Manufacturers of Chilled Car Wheels. This organization acts as a clearing house for information which the individual members acquire or which they may desire. Any manufacturer seeking to obtain information is helped willingly and the freedom with which chilled iron car wheel manufacturers give out information of real service to the industry was shown by their attitude when material for this article was sought from different members of the association. Not only were direct questions answered, but a desire was manifested to give all possible assistance.

The manufacturers work to better the quality of the wheel and to suggest improvements while the car builders' association acts as a referee to pass upon the recommendations o the foundrymen. That the producers should apparently be more interested in raising the quality of the product than are the users may seem strange. However, it must be considered that other kinds of wheels can be purchased if the chilled wheel does not give service. This would react to the detriment of the manufacturer. With the two societies working together, the status of the chilled wheel is being raised and its reliability now is universally acknowledged.

Aside from these two organizations, the testing departments of a number of the railroads are busy collecting data, and in analyzing and examining under the microscope the metal in wheels which have proved defective in service.

Life tests, also, occasionally are made, but when a car is purchased by a railroad and loaded to be sent to some other road, it is possible that it never may be returned to the original owner. The foreign car can be kept by its possessor and sent from one road to another as long as it is in service. The original purchaser secures rental for the car and so can afford to allow the other roads to hold it. Records are made of cars as they pass the terminal points of the different divisions. This furnishes a means of finding a car.

Railroads Investigate

However, this occasional check would be impractical in following the movement of a car to ascertain service statistics. For this reason, life tests of wheels on freight cars are not made. However, records frequently are kept of the mileage of chilled wheels on locomotive tenders. In one of these recorded tests, eight wheels were used, and they each traveled from 30,000 to 33,000 miles before it was necessary to discard them. From the data the railroads gather through their various sources, information is secured which, from time to time, is incorporated into the specifications of an individual road. The roads are not compelled to follow the recommended practice of the M. C. B., although this generally is done, at least in regard to the principal points. Frequently specifications with higher requirements than the usual are put out by the railroad. For wheels to these special specifications of the individual railroads the purchasers must usually pay an extra price. For this reason such wheels generally are used only where the service is particularly severe or where unusual measures are desired for safety.

Wheels Are Heavier Than Formerly

The first wheels designed were for much smaller cars than now are in service. The old 10-ton car was equipped with a 515-pound wheel. At present, the smallest wheel standardized for freight cars weighs 625 pounds. This is used on cars with a maximum gross weight of 95,000 pounds. Three other wheels have been adopted as recommended practice by the M. C. B. These are the 700, 725 and 850-pound wheels for cars of 132,000, 161,000 and 210,000 pounds maximum gross weight respectively.

Two of these wheels, as shown in Figs. 1 and 2, are the old double curve design. This double curvature may be noticed in the plate at the front side, which is shown on the lower portion of the illustration. Figs. 4 and 5 illustrate the newest design of wheels which have the arched plate with but a single curve on the front side. The four wheels, as may be noted, have the same tread and flange. The main difference is the thickness of the plates and the section of the brackets. The number of brackets is the same for all wheels, except the heaviest wheel which has 15 instead of 14 brackets as are on the others. The arched-type wheel is favored by the manufacturers and it is possible that all the wheels of the recommended practice of the M. C. B. ultimately will be this type. Another standard wheel for cars of larger capacity now is being considered and later may be adopted as recommended practice.

The problem which confronts the metallurgist in making the chilled iron car wheel is diagrammatically illustrated in Fig. 3. This shows the section of a broken car wheel with its hard white iron rim, tread and flange, and the soft plates and hub. At the circumference all the carbon is in the combined state and produces an exceedingly hard iron. This governs length of life of the wheel. If this section of white iron is too thin, the length of service of the wheel will be materially reduced; while, if it is too thick, the danger of cracking is greatly increased, due to internal strains. The importance of considering such strains may be realized

when it is remembered that white iron contracts approximately ¼-inch per foot, while gray iron such as is in the center of the wheel will contract only ⅛ inch per foot. These two irons, widely divergent in character and governed by different coefficients of expansion, are laced together by a network of mottled iron. The mottled effect begins to show at the point marked No. 2. Drillings from this portion showed that there was only 2.20 per cent carbon as compared with 3.49 per cent at the outer edge, the difference being precipitated out in the iron as graphite. Further toward the center of the wheel at the place marked No. 3, the combined carbon was reduced to 1 per cent. At the point, No. 4, the combined carbon was 0.80 per cent. The combined carbon in the remainder of the wheel toward the hub will not vary greatly from the amount of combined carbon at the point marked No. 4. The iron immediately around the chaplets which may be more or less chilled, is the one exception to this condition. The foregoing shows that the metallurgical side of the manufacture of the chilled iron car wheel is complicated. Different views regarding some of the details are held by those most experienced in wheel manufacture. The effect and the proper amounts of silicon and phosphorus for the metal in the wheel generally are agreed upon by the different authorities. The amount of silicon is varied to control the chill and will range from 0.45 to 0.70 per cent in standard car wheels. The percentage of phosphorous is kept comparatively low. It usually is found within the limits of 0.20 and 0.40 per cent. These limits are observed because phosphorus weakens iron, and only enough is required to give fluidity. The fact that plenty of pig iron may be purchased within these limits, to an extent, is a determining factor.

Differences of opinion are found in regard to the effect of sulphur and the amount of this element allowable in a wheel. One manufacturer states that he has never reached the limit where sulphur showed itself harmful to the wearing qualities of the wheel, or was detrimental to the wheel from a service standpoint. Further, the claim is made that sulphur hardens the chill and increases the life of the wheel. The sulphur content has been carried as high as 0.220 per cent and the only objectionable feature was from the foundry standpoint, the iron being subject to gas holes at the tread and flange, and likely to develop chill checks. Other authorities are insistent on keeping the sulphur low, a sulphur content of from 0.110 to 0.140 per cent being sought by many. Furthermore, some railroads pay a special price for low-sulphur wheels. The difference of opinion as to the effect of sulphur in the iron is especially noticeable between the manufacturers of freight car wheels and those making mine car wheels. While the former use a large amount of scrap and do not make special efforts to keep the sulphur lower than 0.10 per cent, some of the mine car wheel manufacturers insist that it is essential that the sulphur in the iron be held below 0.10 per cent. A great amount of scrap is purchased for the manufacture of the standard wheels, but few mine car wheel foundries use any other than that which originates within their own shops. The main purpose of this precaution is to keep down the percentage of sulphur in the iron. The action of manganese is closely related to that of sulphur. Manganese is varied from 0.40 to 0.80 per cent. It forms with sulphur a compound, manganese sulphide, which is made of one atom of manganese and one atom of sulphur, as the formula, MnS, indicates. As the atomic weight of manganese is 54.93 and the atomic weight of sulphur is 32.06 it may be seen that the two elements combine in these proportions. Thus slightly more than 1.4 times as much manganese as sulphur is required to form a complete combination. The maximum amount of sulphur found in car wheel iron is 0.220 per cent, and this would require only 0.30 per cent manganese to combine without excess. There also is a tendency for the iron to unite with the sulphur in the form of iron sulphide and therefore all the sulphur will not combine with manganese and an excess of manganese is added to the iron to take up a larger proportion of the sulphur. The state of the sulphur in cast iron is a debatable point. One prominent metallurgist advances the theory that sulphur exists in several different states in iron. It is thought that the sulphur taken up from the cupola, or in the original pig iron, affects the resulting product to a greater extent than sulphur from scrap iron which has been melted a second time. No proofs of this are offered other than general observations from long practice, and no definite suggestions are made as to the states in which the sulphur exists in the iron. That manganese sulphide does not

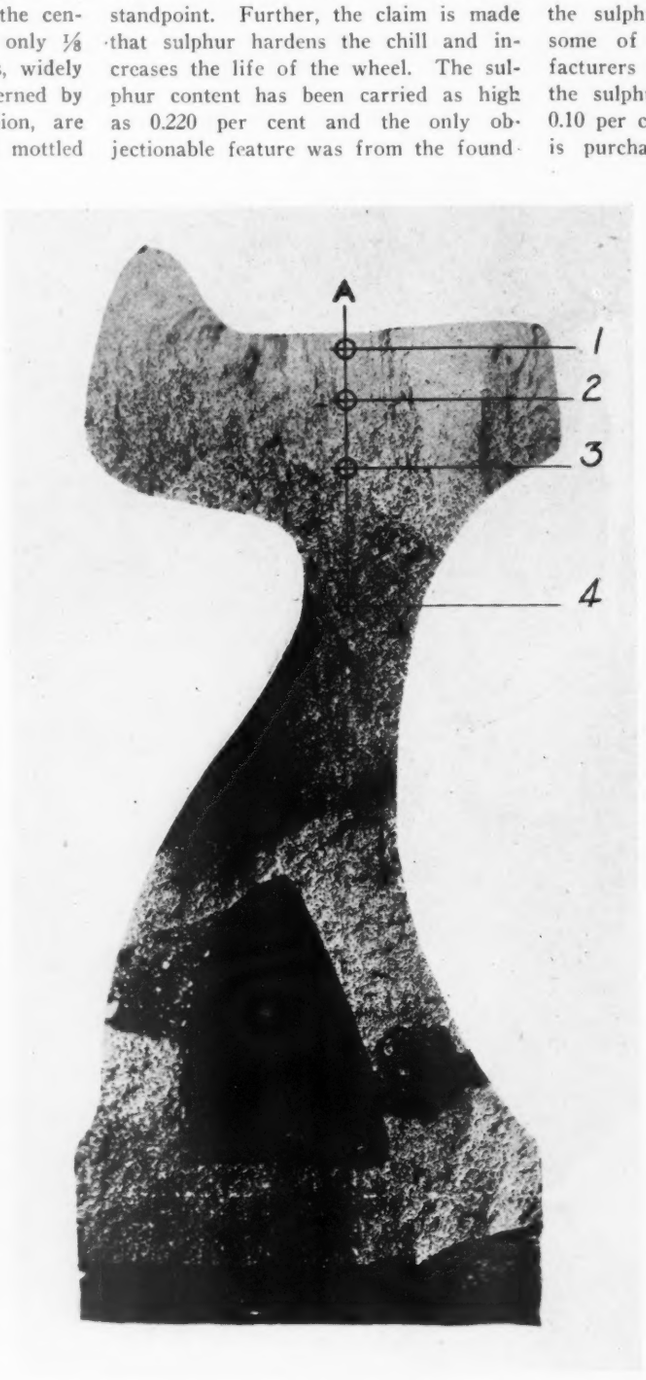


FIG. 3—CARBON IS ALL COMBINED IN THE CHILLED SECTION AND GRADUALLY COMES OUT OF COMBINATION UNTIL AT THE POINT NO. 4 THERE IS ONLY 0.80 PER CENT COMBINED

exist in iron to anything like the full extent of all the sulphur present, may be surmised from the fact that manganese sulphide is lighter than iron and tends to rise to the surface. Should all the sulphur exist as manganese sulphide it might be judged that more of it would rise to the surface and pass into the slag. Thus with sufficient manganese a low-sulphur iron always could be obtained.

The debatable character of the state of sulphur in the iron is emphasized by the difference of opinion as to the proper way to add manganese to the iron. Some metallurgists add all the manganese to the mixture in the cupola in the form of high-manganese pig iron. Others add the manganese to the melted metal after it comes from the cupola. It is claimed that by the former method a greater amount of sulphur is taken from the iron. Advocates of the latter method state that results are obtained from the manganese when it is added to the molten metal, which are not shown when the addition is made in the cupola. One of these results is that less manganese is lost. The main claim for manganese is that it has a softening effect, and also that it strengthens the metal when present in amounts up to 1.2 per cent. It also, to some extent, neutralizes the action of sulphur, as manganese sulphide is neutral in its effect on the iron. When the manganese is added to molten iron, manganese sulphide rises to the top, even though the iron originally had a high percentage of manganese which it might be expected would produce the effect of bringing manganese sulphide to the top without the further addition of manganese.

Manganese Added in the Ladle

Manganese is added to the iron from the cupola in the form of spiegeleisen or ferromanganese. The spiegeleisen contains less manganese than does the ferromanganese and it is necessary to add a larger proportion of it. On this account it is added to the large receiving ladle, or in the cupola. Usually the ferromanganese employed contains 80 per cent of manganese. It is added either in the mixing ladle or in the bull ladle from which the wheels are poured. The bull ladles hold about 1000 pounds of metal and one wheel is poured from the contents of one ladle.

Of course, the amount of manganese added to the metal varies in different foundries. One foundry which taps 15,000 pounds of metal at a time adds 15 pounds of lump 80 per cent ferromanganese to the mixing ladle before tapping. This practice gives the iron ample time to absorb the manganese, as approximately five minutes are required to tap the full amount of metal and no wheel is poured from the ladle of iron before the entire 15,000 pounds of metal is delivered from the cupola. When manganese is added to the bull ladle the amount varies from ½ to 3 pounds to the wheel. This also, usually is added in the form of 80 per cent ferromanganese, but instead of being in the lump form it is ground either to a powder, or at the most, to pea size. It is not weighed but gaged in a suitable measure. By adding the lump manganese to the mixing ladle the expense of grinding is saved, and one foundry which has changed from the powdered to the lump form advises that this saving is worth considering.

Charcoal Iron Used

One point generally agreed upon, is that charcoal iron in the mixture is beneficial to the wheel. Manufacturers almost invariably add charcoal pig to the mixture when making special wheels for which they guarantee better service than for the regular wheel. Charcoal iron rarely is used in the regular wheel as foundries can make wheels to meet the generally accepted specifications with the cheaper coke iron and scrap. Therefore expensive charcoal irons are used only when a special wheel is ordered which commands a higher price. However, the amount of charcoal pig which it is advisable to use and the degree to which charcoal iron is beneficial to the iron are points not generally agreed upon among wheel manufacturers. It is said that charcoal pig iron strengthens the iron, preventing the wheels from cracking. The claim also is made that it rejuvenates the metal giving it more life and making it easier to handle in the foundry. On this question some manufacturers of mine-car wheels are emphatic and will not try to make mine-car wheels without the addition of charcoal pig to the mixture. Some firms use as high as 25 per cent of charcoal iron in their mixture.

The necessity of a strong wheel is emphasized in mine-car practice. These wheels frequently are made with spokes instead of a plate, and the rim, tread and flange between the spokes must bear the weight of the burden. The rims of these wheels vary from ½ to 1¼ inches in thickness and have a chill ¼ to ½-inch deep. The toughness and strength necessary in such a case are secured, it is thought, from the use of charcoal pig iron. It is claimed that a mixture containing charcoal iron will shrink less than one containing none, and thus prevent the spokes from cracking under cooling strains. In the mine-car wheel foundry much is heard of the *sulphur chill* and the *charcoal chill*, the latter being considered superior in most cases. The advisability of the use of charcoal iron is closely related to the question of whether the brand of iron affects the quality of the metal, providing the analysis is not varied. Many metallurgists emphasize brand consideration while others claim that two coke pig irons of the same analysis from different sources will produce like results. One metallurgist states that when he started to mix iron for car wheels, about 20 years ago, he thought that all he needed to do was to secure the correct composition for the iron and the wheels would be satisfactory. However, his experience taught him that certain brands of iron were better than others, no matter if the composition was the same. Now he always uses two, and sometimes as high as four brands of iron in his carwheel mixture. This practice of using several brands of iron in the mixture is largely followed in foundries making wheels for mine cars.

Other metallurgists of equally long experience say that there is nothing in the claim that one brand of iron is better than another of the same composition. The contention of those who say that the brand does make a difference is borne out when the extremes are considered. Take for example, a cold-blast pig iron such as is made in England. This iron will stand a tensile test as high as 40,000 pounds per square inch in test pieces cut from the pig; while the hot-blast iron of identical composition will show a tensile strength of 20,000 pounds per square inch, when sampled in the pig. This difference can be explained by the variation in the shape and size of the carbon particles. In the cold-blast iron these particles are in a rounded form similar to the temper carbon in malleable iron but in slightly larger masses. The graphite of the hot-blast iron appears in long flakes, as is generally known. These flakes through breaking the continuity of the metal structure weaken the iron. The grain of the cold-blast iron also will be finer.

Cause for the Effect

This extreme case offers a possible explanation as to why brands of hot-blast iron might vary from one another in their physical qualities, although not to so great an extent. There are other possible reasons for differences. It has been demonstrated that the presence of small fractions of a per cent of alloys make an appreciable difference in the physical qualities of steel, and it is possible that some ores may contain some of the rare elements which, although in small proportions, might be enough to effect the quality of the pig iron. Further, there is that question of oxygen which opens the subject of the effect

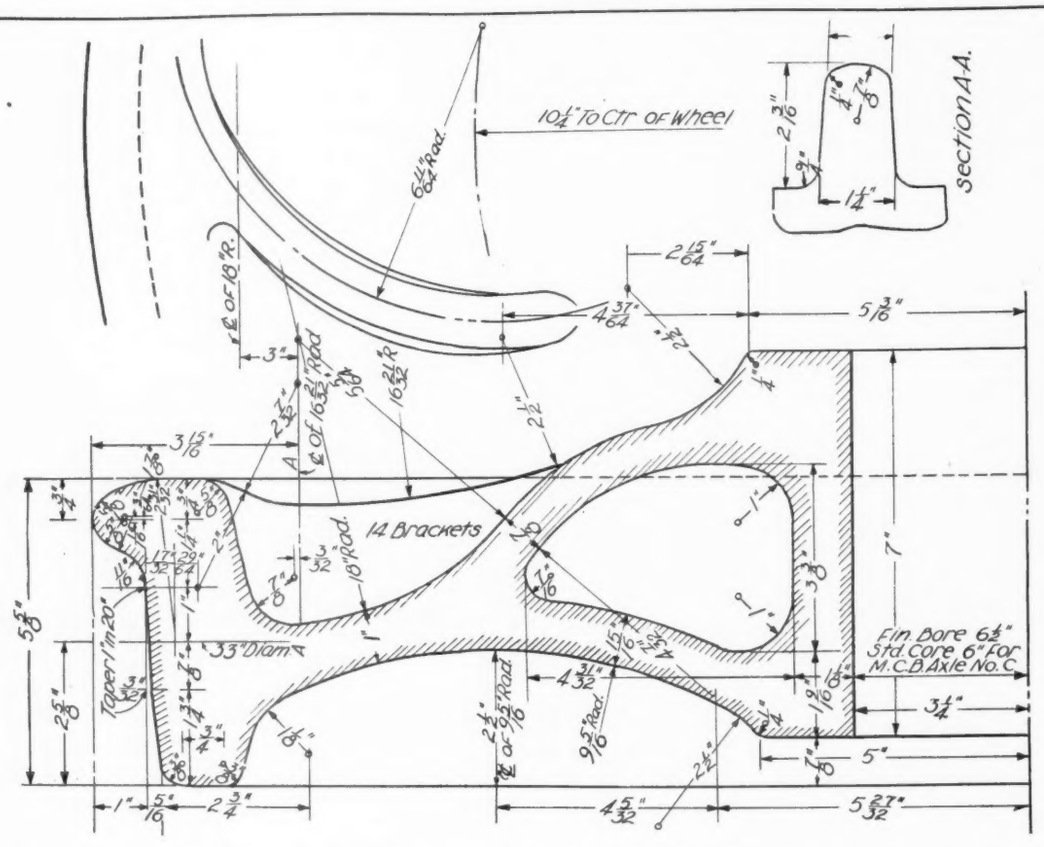


FIG. 4—CAST-IRON, 33-INCH WHEEL FOR CARS OF MAXIMUM GROSS WEIGHT NOT EXCEEDING 132,000 POUNDS—THIS IS A RECENT DESIGN AND HAS A SINGLE ARCH IN THE FRONT SIDE, FACING DOWN IN THE ILLUSTRATION

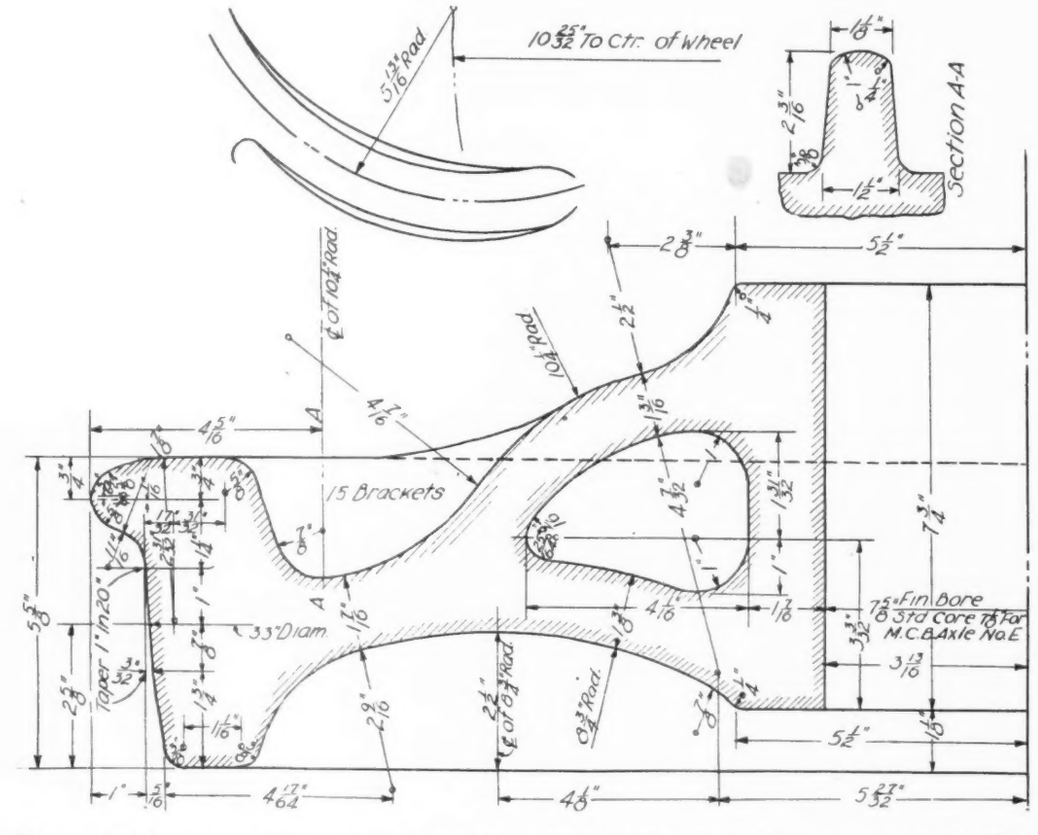


FIG. 5—CAST-IRON, 33-INCH WHEEL FOR CARS OF MAXIMUM GROSS WEIGHT NOT EXCEEDING 210,000 POUNDS—THIS IS THE HEAVIEST WHEEL STANDARDIZED BUT A WHEEL FOR HEAVIER CARS IS PLANNED

of gases in general upon pig iron. So little really is known of this, that it would be difficult to controvert claims made in regard to the effect of the gases on pig iron. However, it generally is admitted that oxidation in the cupola decreases the fluidity and increases the chill.

One outstanding fact that confronts the metallurgist in calculating his mixture is that every wheel that is made ultimately is scrapped, and the purchaser of the wheel thus has scrap of which he must dispose. The natural place to sell old wheels is to the foundryman from whom the new ones are purchased. This gives the foundry a large amount of scrap which must be used in the mixture. The old car wheels being high in sulphur, it is difficult to keep at a low point the sulphur content of the new wheels. Therefore, the mixture usually contains 60 to 70 per cent scrap, including old car wheels, and risers and scrap from the local foundry.

Steel in the Mixture

In addition to the cast-iron scrap a small amount of steel scrap is added to the mixture in many foundries. This usually amounts to 5 and sometimes 10 per cent of the mixture. On experimental runs, as high as 60 per cent of steel scrap has been used and the resulting wheels have passed all the M. C. B. tests. However, such a mixture would hardly be practical, because the amount of carbon taken up by the melting steel from the coke would vary largely from one portion of the heat to another. This would cause a variation in the depth of chill and in the diameter of the wheel, due to the fact that a low-carbon iron would shrink more than one with higher carbon and one of the essentials in making car wheels is regularity.

The quality of coke used together with the method of charging it and the amount of air supplied are given careful consideration. Some foundries have complete specifications for coke. Such specifications often include in their requirements for composition the limit for ash, fixed carbon, sulphur, moisture, volatile matter and even phosphorus. The weight in bulk and the crushing strength also are sometimes included in the specifications. One foundry requires that the coke shall weigh not less than 40 pounds to the bushel, and that it shall have a crushing strength of at least 275 pounds per cubic inch. However, at the present time it is almost impossible to purchase coke to specifications which have limits other than the maximum amounts of sulphur and ash. It would be difficult to persuade any coke manufacturer to guarantee a maximum of much less than 1 per cent for sulphur and 12 per cent for ash. These limits are satisfactory to most car-wheel manufacturers.

Low Blast Pressure

The benefit derived from good coke may be negated by improper charging and too much or too little air. In charging the cupola, it is well to make the bed about 30 inches above the tuyeres. The blast pressure should be as low as is consistent with getting hot iron. One foundry has reduced the blast pressure at times as low as 8 ounces and never carries over 10 ounces. The advantage of low blast pressure is that the bed of coke is less likely to be burned out, with the resultant oxidization of iron and the burning out of silicon. Either of these effects would increase the depth of chill. Normally 0.20 per cent of silicon is lost during the melting of the iron. This figure is rather constant unless unusual melting conditions exist. The melting ratio is closely related to the quality of coke. Some foundries report that they are melting with a ratio of slightly more than 10 to 1, calculated on the amount of coke on each charge but not including the bed. Others report the melting ratio to be nearly as low as 1 to 7, which is the minimum.

Pointers for Cleaning Room Foremen

BY SNAGGING is generally meant the rapid removal of large quantities of metal from castings as they come from the molds. After snagging, the larger castings have areas to be ground and considerable quantities of metal to be removed, whereas small castings may require only a little grinding where the sprue has been broken off.

In common with other machining operations, most efficient results are obtained only by using the most efficient tools. Probably there is no other machining operation with so great an opportunity of varying the tools as grinding. Because of this, grinding should be an efficient process.

Choice of grinding wheels is dependent upon the following factors: Kind of material to be ground; size and shape of casting; finish desired; amount of stock to be removed; kind and condition of machines; wheel speeds; personal factor.

Rough castings with thin sharp fins and covered with considerable semi-vitrified sand require harder wheels than smooth castings with large plane surfaces. The better the finish required, the finer the wheel must be, and the wheel must be of a softer grade in order that the cutting action may not be decreased to a great degree. Large amounts of stock may be removed faster with coarse wheels than with fine ones. There is an exception to this rule. When the limit of depth to which a grain can penetrate is reached, a coarse wheel will retard production rather than increase it. A wheel should be coarse enough only to allow maximum penetration and clearance.

Floor and bench stands of rigid construction set on firm foundations require softer wheels than portable machines of the swing frame or flexible shaft type, because there is less vibration in the former group. Poor bearings make harder grades necessary for the same reason. Rotating parts out of balance have the same effect.

Small castings up to about 100 pounds are ground on floor and bench stands usually mounted on two wheels. Castings which cannot be handled by two men or by the help of a small chain hoist are ground with swing frame grinders. For grinding in grooves and corners of large castings, a small portable machine is useful. These made in three types, electric, pneumatic and flexible shaft.

There is no standard size wheel which is best for snagging. In general it is advisable to use as large a wheel as possible on a machine, for the larger the wheel the fewer the stubs to be thrown away. There are three reasons why the material per cubic inch of wheel wear constantly decreases as the wheel wears. These are decreased wheel speed, reduced arc of contact and reduction of the momentum. As the wheel wears the surface speed decreases unless the revolutions per minute are increased constantly so that surface speed will not vary from the standard.

The smaller the diameter of a grinding wheel the smaller the arc of contact and the fewer the number of particles that are cutting at any particular instant. The rotation of a larger wheel gives a much greater momentum than does a small wheel. When high pressure is applied this momentum is helpful in pushing the particles through the metal. It is comparatively easy to

(*Concluded on page* 292)

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Patterns for Jobbing Pipe Work-II

Methods of Striking-off the Cores on Trestles and With Sweeps on Flat Plates Are Described and Various Types of Arbors and Grids Are Illustrated

BY JOSEPH HORNER

FROM the consideration of pipe patterns made in wood we pass to a discussion of loam pattern work. Patterns swept in loam are used extensively when pipes are of large diameter, or whether large or small they are of irregular and unusual outlines and are ordered singly or in small numbers.

Regardless of the outline of a loam pattern, jointing is practically impossible in a manner similar to that followed with wood patterns. Even though loam patterns are swept in halves on plates, no attempt ever is made to dowel the loam, but the halves are cemented together before molding, making a solid pattern. Necessarily, when a cylindrical pattern, whether parallel or tapered is swept-up, it is swept on a barrel like a core, without a joint. The result is the difference between withdrawing the pattern from a turned-over cope, and lifting the cope mold from the pattern. To increase the disadvantage the surface of loam is rougher than that of wood, notwithstanding applications of tar or varnish and the edges of the top part of the mold generally break up considerably. The edges must be repaired with a sweep laid and held against the broken parts, and a trowel also is used. For this reason pipes of large size often show over-lapping edges in places.

Flanges Difficult to Set

Another difficulty with loam patterns is that of setting flanges. On a wood pattern they are set by means of lines drawn on the joint faces and checked by a square worked off the joint faces, or with a set square from a board on which the pipe is drawn to actual size. In unjointed loam patterns they must be measured and checked by the outside of the body. But in loam patterns that are swept in halves, the positions of flanges and other attachments can be marked from the joint faces to the outside before the halves are cemented. They also can be set up from the full sized drawing usually supplied by the patternmaker for work of this kind. Screws cannot be used to attach flanges and fittings to loam, but the little wooden brackets sometimes employed on wooden patterns can be employed, being kept in place with long, fine nails pushed into the hard loam, which will hold sufficiently well for the purpose. When practicable, it is advisable to form a shoulder in the loam for the flanges to lay against.

Patterns Used for Cores

Because of the risk of lapping joints resulting from the fracture and repair of sand, a frequent practice is to check the coincidence of top and bottom edges with squares of paper, shown at *A* in Fig. 58. These are laid upon the bottom with one edge close to the mold edge, and a small spot of clay is daubed on top of the paper. When the cope is lowered on for trial the clay wafer adheres to it, and on lifting the cope the slips of paper lift with it, when it may be noted whether or not the edges in top and bottom coincide.

Loam patterns for pipes are made in two ways. In one they are used as patterns only; in the other, they include the functions of both patterns and cores. By the first method, the patterns are swept in the quickest and stiffest manner possible, without regard for venting. By the second method, the actual core which is intended for use in the finished mold is first made precisely as though a wooden pattern were to be used. The core is then dried and blackened and a coat of loam is struck over it of the same thickness that the casting is to be. This is the *pattern thickness* and the mold is rammed around this, after which the *thickness* is broken off, leaving the core intact underneath ready for insertion in the mold.

The question whether the core shall be struck first and a thickness run up on it afterwards mainly depends on the number of castings required. When one only is wanted, then it is usual to adopt this method, but not when more than one is ordered. If several castings are required, cores have to be made for all and there is no advantage in utilizing one as a basis for the pattern. In the case of swept-up cylindrical pipes a larger barrel can be used for a pattern which requires no venting than for a core which does, and the pattern can be made correspondingly stiffer.

Both patterns and cores, for the present treatment, are divisible into two classes, those which are swept symmetrically upon a revolving barrel or arbor, and those which are swept to various plan outlines upon grids. There is considerable difference between the two. Making a pattern of a straight, cylindrical pipe in loam is easier than making that of a bend pipe. But straight pipes are seldom made in this way, unless they are of fairly large diameters, say of over 8 or 10 inches. They are frequently swept-up for special reducing pipes or for any odd bores not standard.

Cylindrical cores are swept on revolving barrels which are made of cast or wrought iron, and pierced with numerous holes through which the air and the gas from the core generated at the time of casting, escapes to the exterior of the mold. Loam patterns, for convenience only, are swept on similar barrels. Hay bands are wound around the barrels to receive the loam and to form a porous body through which the gases rush into the interior of the barrel. Hay bands may be bound around a barrel for a pattern, but this is merely for convenience to increase the size without using an excessive thickness of loam.

Making Cylindrical Cores

Fig. 31 shows the general scheme of sweeping-up a core on a revolving barrel, Fig. 32 is an end view, and Fig. 33 a cross-section. The board is supported on iron trestles with a series of graduated V's to receive a range of different sized barrels. It is clamped to the trestles, or weighted, or clamps and weights are both employed. The edge of the board is set carefully to the radius that corresponds with the diameter of the core. A long board also must be supported at the center, or it will sag and the diameter at the center will be larger than that at the ends. If the board is not securely clamped, the pressure of the revolving loam, which is stiff, will push it outwardly, increasing the diameter. When the work nears completion, checking it

with broad-faced calipers is necessary, and again after drying.

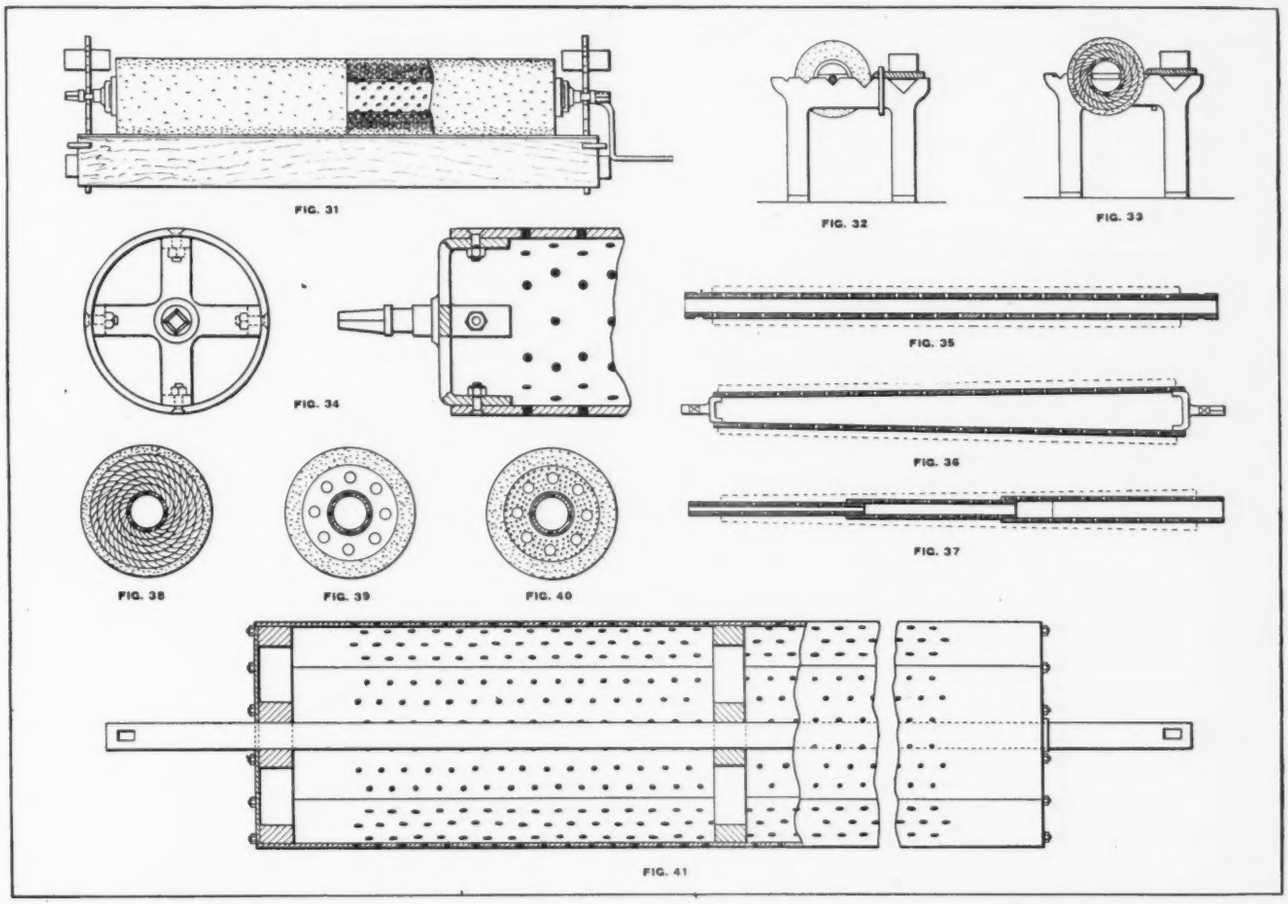
The broken section in Fig. 31 shows the barrel, two rows of hay bands, and the outer coat of loam. When sweeping-up, the barrel is first moistened with clay water to receive the bands which are wound on fairly tight by the coremaker, with loam daubed between them, followed by a covering thickness of coarse loam. A little time is allowed for this to stiffen before the final coat of thin, sieved loam is swept on, after which the core is dried in the oven, to be afterwards smoothed with a rasp and coated with black wash.

An enlarged view of the end of a core barrel is shown in Fig. 34. This has four claws for the trunnion in place of two as shown in Figs. 31 to 33. These are made of cast iron, bolted within the ends of the barrels, and turned on the neck that runs in the V's. Figs. 35 to 37 are sections through core barrels for parallel and tapered pipes, respectively. They are made of cast iron in the larger and medium sizes and of wrought iron pipe in the smallest sizes. The first have the vent holes cast in, in the second they must be drilled. Fig. 37 shows wrought iron pipes made up telescopically for a tapered core.

Fig. 31 represents one of the smaller cores having only two thicknesses of hay bands. Large cores must have several, as shown in Fig. 38. The cost of hay bands and labor is considerable, and the bands and loam sag in drying. In such cases support is afforded to the bands with thin iron plates, Figs. 39 and 40, cast with holes in them to facilitate breaking and their removal from the casting, and to permit of the passage of long bolts to tie the end plates. But in such cases it is advisable to use larger barrels, Fig. 41, and only a single layer of hay bands. The objection to this practice is the binding of the barrels in the casting due to the shrinkage of the latter; to avoid this is the reason for the employment of collapsible barrels, but these concern the regular and not the jobbing pipe shops.

Core barrels should be as large as is practicable, because the stiff barrel requires less support from chaplets than one that sags. Over the barrel the rope should be wound in sufficient quantity to reduce the loam to a very moderate thickness. The smaller the thickness of loam the better the venting, because the hay bands are porous. The loam surrounding the bands ranges only from ½ to 1 inch in thickness and is not vented. The vent holes in the barrels are closely located so that as soon as a pipe is poured the gas begins to rush out at the ends of the corebarrels.

Unsymmetrical cores are swept in halves, either against guide irons or against the edges of iron plates. The result in each case is the same, namely, the formation of a core of a definite contour. The difference is that in the first case the cores are struck upon any large flat plate, which may be carrying a number at one time and in the second case a separate plate is required for each half core. The latter permits of the drying of the core in a small stove, and the plate remains permanent in case repeat orders should be called for. Guide irons have to be bent and set by a full-sized drawing, and checked and corrected if used later for a similar job.



FIGS. 31 TO 33—SWEEPING A CORE ON A REVOLVING BARREL. FIG. 34 IS AN END VIEW OF A CORE BARREL WITH FOUR CLAWS. FIGS. 35 TO 37 ARE SECTIONS OF CORE BARRELS FOR PARALLEL AND TAPERED PIPES. NUMEROUS THICKNESSES OF HAY ROPE ON A CORE BARREL ARE SHOWN IN FIG. 38 AND FIGS. 39 AND 40 ILLUSTRATE SUPPORTS FOR THE BANDS. A LARGER BARREL AND ONLY ONE LAYER OF HAY ROPE IS SHOWN IN FIG. 41

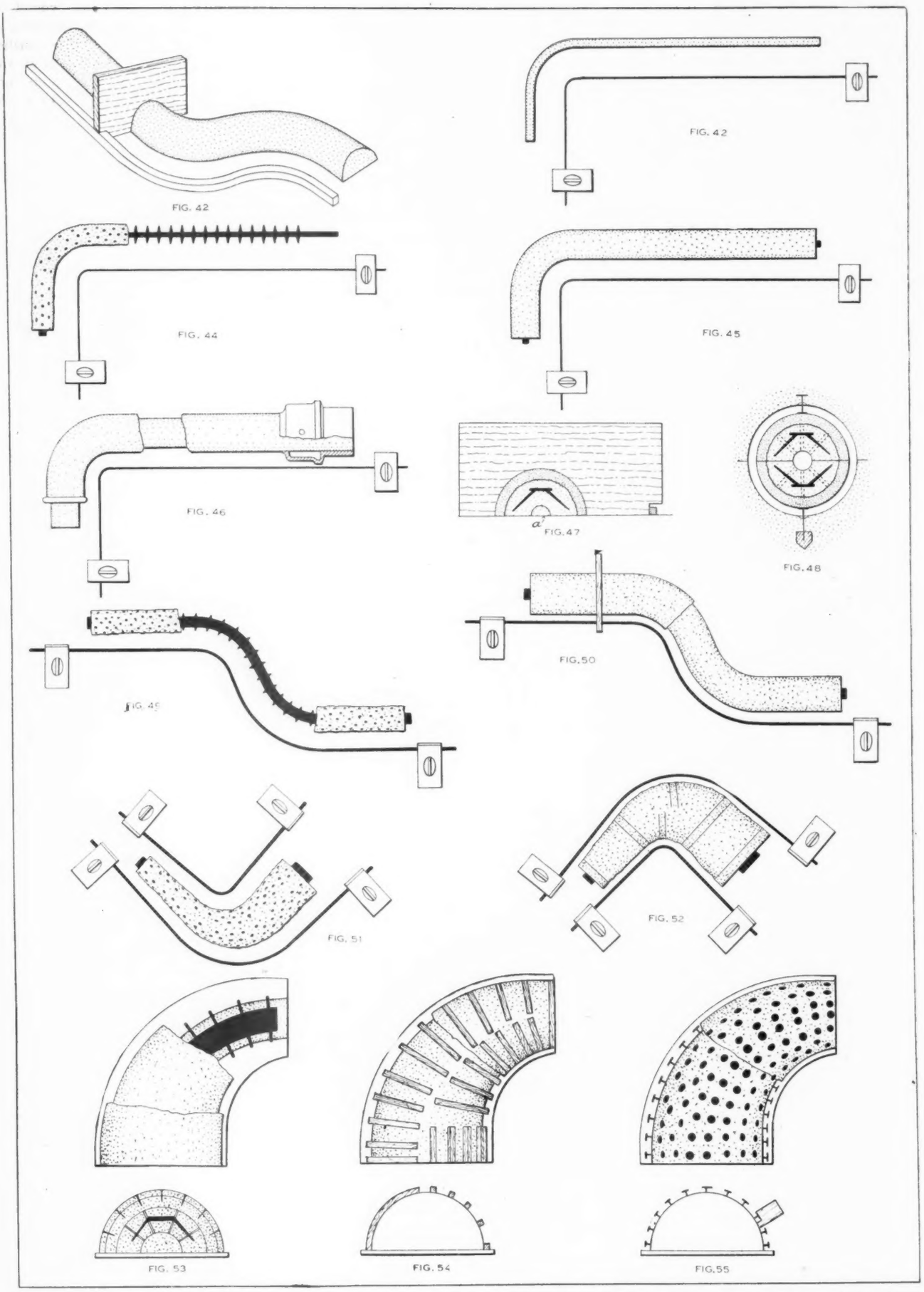


FIG. 42—SWEEPING AN UNSYMMETRICAL CORE. FIGS. 43 TO 46 SHOW STAGES IN SWEEPING A SOCKETED BEND. FIGS. 47 AND 48 ARE SECTIONS THROUGH A HALF CORE AND PIPE MOLD. FIGS. 49 AND 50 ILLUSTRATE THE METHOD OF SWEEPING AN S-PIPE. FIGS. 51 AND 52 ILLUSTRATE THE MAKING OF PIPE BEND CORES AND FIGS. 53 TO 55 ARE DEVICES FOR INSURING UNIFORM THICKNESSES OF METAL IN CAST PIPES

The sweeps used have to be cut to suit the method selected. If a guide iron is employed, the sweep is shouldered as in Fig. 42, but for a plate the shoulder is cut down to make contact with the edge of the plate. The distance to which the shoulder extends from the edge of the core is not important except in a relative sense. That is, the guide iron, or the edge of the plate can be set at any reasonable distance from the edge, but this being fixed, the shouldering edge of the sweep must correspond with it. If not, the bend struck will not be of the correct radius. Also, the core sweep and pattern sweep must vary in the distance of their shouldering from the core and pattern, by the thickness of metal required in the casting.

Grids Are Employed

A core produced with a sweep must be stiffened by means of a grid just as a cylindrical core requires the support of a round barrel. As the unsymmetrical cores are struck in halves upon plates, two grids are needed, one for each half. These are cast as light as possible, consistent with the necessary rigidity. The forms generally given to them comprise a rib or ribs running longitudinally with short ribs or prongs radiating therefrom. Details differ according to the sizes and shapes of pipes. Upon and around these ribs and prongs the loam is daubed and swept.

In order to avoid distortion, and to obtain good shapes, pipe patterns cannot be struck up at once, but the process must be spread over several hours, and in the case of the largest pipes, over two or three days. The details of the work are as follows:

Figs. 43 to 46 represent stages in sweeping a socketed bend, using a guide iron set and held securely with ordinary 50-pound weights. Two sweeps are used, one for the core and one for the pattern. An iron pattern socket is required and a lead bead for the spigot. One-half only is shown. The other half is swept at the same time, employing identical but reversed guide irons.

The first stage is that shown in Fig. 43, where a slender body of loam is shaped on the plate to form the central vent for the core. This is scooped out later and is shown at *A*, Fig. 47. When it has set stiffly parting sand is dusted over it, and the half core is commenced with the stage shown in Fig. 44.

In the case of bend pipes, which differ from those swept on perforated core barrels, the methods of venting differ according to whether the core is made in a box, or swept-up on grids. If made by the first method, vents are driven with a wire just as is done in ordinary molding. They are taken from the outer portions of the cores into a central channel or gutter cut with the trowel in the joint faces of the half cores before they are cemented together The air escapes along these gutters and finds exit at the ends. When a core is swept-up with strickles, the gutters are still formed, but they are made by laying down a body of sand on the iron core plate of the same cross-section as the gutters, and the loam of the core is bedded and strickled upon this. The sand is removed after drying the half cores, and before they are cemented together. Since no hay bands are used, the loam is vented into the gutter by driving a strong vent wire into it after the loam has become stiffened, but before it has been dried. This only applies to the first or roughing coat. The second or finishing coat being thin, need not be vented with the wire, since the air will strike through it freely.

As a basis for the core, the grid, Fig. 44, is laid upon the plate on a stratum of stiff loam, and coarse loam is daubed all around the rib and prongs until the outline is brought to resemble roughly that of the pipe core, but smaller, and the sweep is not yet brought into use, the hands alone being employed for the rough daubing. The appearance of the work at this stage is shown at the left, Fig. 44. Holes are shown indented with the fingers to assist in securing the next application of loam. The work now is put into the oven to dry, or is left for a night to stiffen after which the final coat, consisting of fine loam, is applied and finished to outline with the core sweep, as shown in Fig. 45. The halves are then dried in the oven. If the pattern is to be swept separate from the core, the sweeping is done in precisely the same manner on grids, but of course venting is omitted. If a *thickness* is to be struck on the core to form the pattern, this will consist merely of a thickness of loam laid on and swept-up with the strickle, Fig. 46, equal to the thickness of metal in the casting. The illustration shows the *pattern thickness* on the core.

Setting the Loose Pieces

After drying in the oven, one-half is laid on the drawing board, and the positions of the socket and spigot, Fig. 46, or of flanges, are marked, and the fittings set accordingly. The halves are then put together, joint to joint, and the second half is marked from the first. The two are cemented, tarred and dried and the bend is ready for molding. Fig. 47 is an enlarged section through the half core before the pattern thickness is laid on, and Fig. 48 is a corresponding section through the mold.

There are two methods of sweeping socket patterns and cores for loam pipes. In one they are struck upon the solid loam, a method which is rather troublesome and may produce unsymmetrical shapes as a result of the corrective rubbing necessary. The other sweeps-up the socket against the edge of a board, to be slid over the pattern body, a method which insures a correct shape.

Sweeping Socket Patterns and Cores

To strike a socket in this way it is necessary to run up a body first on a revolving barrel to the same diameter as that of the outside of the pattern on which the socket is to fit. Blacking is painted over this before the socket is struck, so that it can be easily slid off endwise, after it has been dried. In Fig. 46 an iron pattern socket is shown put on the loam pattern. A loam socket would be fitted similarly on the body only it would not be hollowed for lightening the same as the iron pattern.

Figs. 49 and 50 show the stages of sweeping one-half of an S-pipe. In Fig. 49 the grid is shown, and the first rough coat of loam. In Fig. 50 a section of the exposed core is illustrated, and a portion of the pattern struck on it with the pattern sweep straddling it.

Many bends have to be struck in which the diameters are not uniform, including sometimes short parallel lengths with shoulders, or with regular tapers. These include socketed bends, bends that carry valve seatings, reducing bends, bends merging from square to round sections, and those in which thicknesses of metal vary with changes in diameters. The making of these involves the employment of more than one sweep, and generally entails considerable rubbing down of intermediate portions of loam.

The bend, Figs. 51 and 52, is an example in which the thickness of metal is reduced from the larger to the smaller end. Two guide irons are necessary here, laid down in the relations shown. Fig. 51 illustrates the first stage of the core roughed-out by hand only, and vented. In Fig. 52 it is nearly completed. For frequent changes in diameter, Fig. 52, a different sweep is required, even though the length to be covered by a strickle is very short. For the

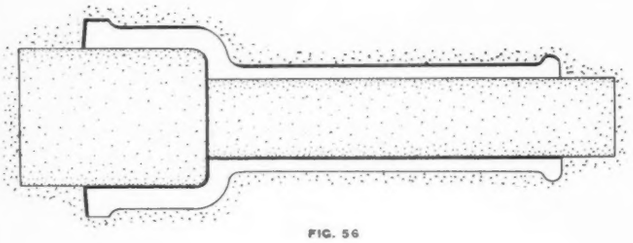


FIG. 56

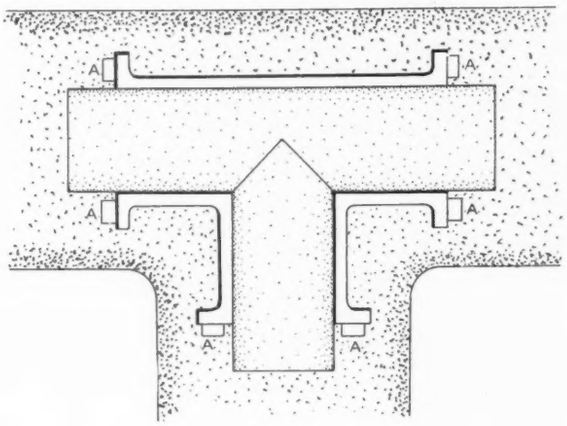


FIG. 58

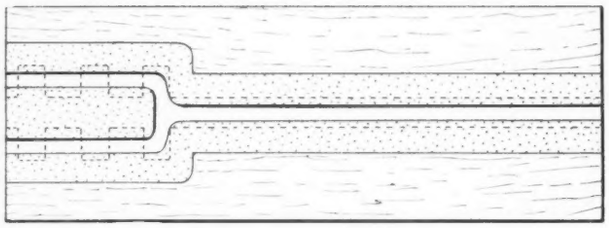


FIG. 57

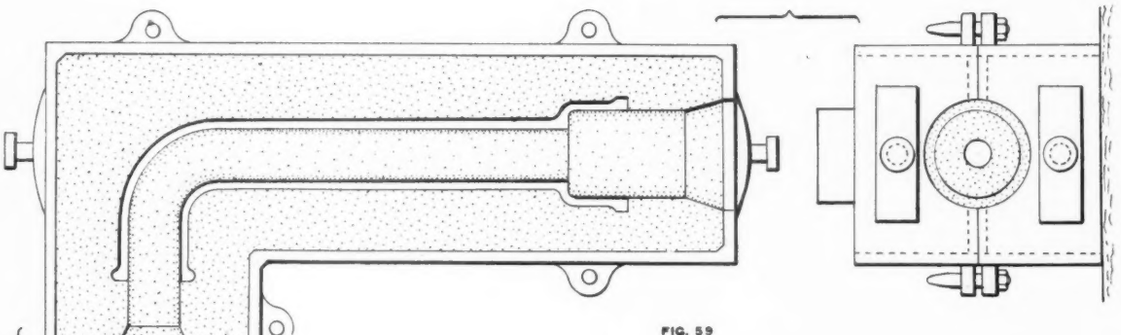
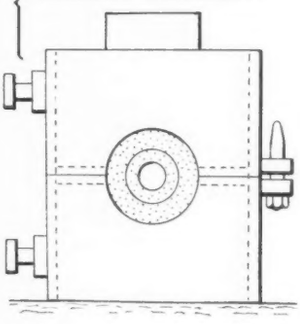


FIG. 59



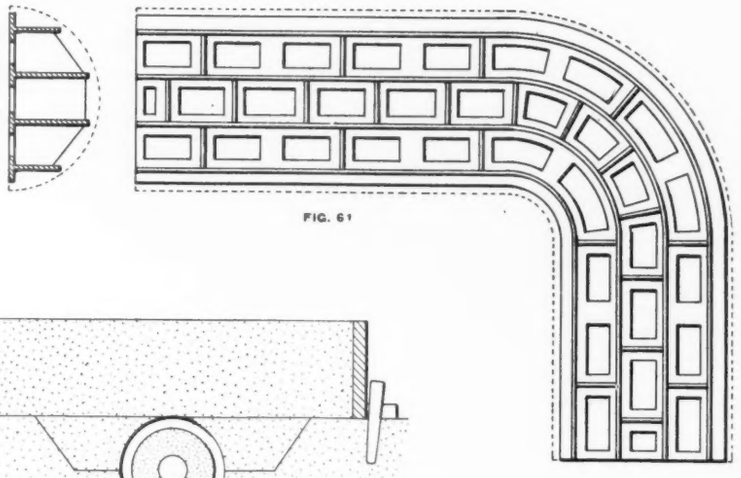


FIG. 61

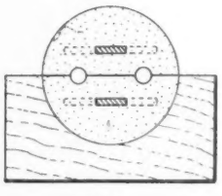


FIG. 60

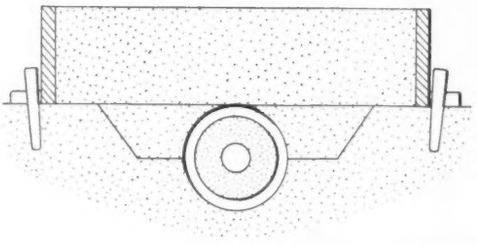


FIG. 62

FIG. 56—SOCKET PIPE CORED. FIG. 57—HALF CORE BOX RAMMED. FIG. 58—CORE MADE IN SECTIONAL LENGTHS. FIG. 59—BENDS MOLDED IN A FLASK. FIG. 60—HALF CORES CEMENTED. FIG. 61—GRID FOR HEAVY BENDS. FIG. 62—A METHOD OF MOLDING IN THE FLOOR

bend portion, two quarter or quadrant sweeps only are required, one for the outer curve and one for the inner one. Some rubbing and correction of the loam is necessary over the short lengths where the strickled curves have to merge into one another. This is done after the mass has been dried. Such a core made in this way for a pipe in which the metal is thin requires a good deal and this method should not be adopted when a number of bends have to be molded, but a core box should have preference.

Insuring Even Thickness

When a bend is of such a form that it cannot be swept wholly with strickles, but has to be finished by hand-rubbing, then the pattern thickness cannot be swept upon it without subsequent rubbing also. It often happens in bends that have much taper, that the thicknesses of metal will show considerable variations when the core is inserted in the mold. This can be prevented by the adoption of simple devices, Figs. 53 to 55, where a half bend is being swept on a plate. Fig. 53 shows the vent channel, grid, core and the pattern thickness in broken sections on the striking plate. One method used to obtain metal thickness is to saw or plane a number of narrow thickness pieces, extending around the curves, or longitudinally, or with both in combination, Fig. 54, the thickness being the same as that of the metal in the casting. Loam is daubed between them, strickled-off level with them and is allowed to stiffen firmly, though not necessarily dried in the oven. Then the strips are taken off, and their places filled with loam which is swept flush with that already set, or dried.

Another method is to push a number of flat-headed nails into the core allowing the heads to stand out a distance equal to that of the thickness of metal in the pipe, Fig. 55, the distance being set by a shouldered gage. These nails, inserted at intervals of 1½ or 2 inches are a sufficient guide for the daubing-on and the finishing-off of the loam to form the pattern thickness. They serve also to retain the loam during molding. In such pipes it is better to make core and pattern in one, as shown, rather than to have a loam pattern distinct from the core. Lastly, in such work, the thickness of metal should be tried. The core, before blackening, is laid in its print impressions, and sundry dabs of clay are laid in various portions of the mold. These are flattened out by the pressure of the core and upon the removal of the latter, the thicknesses of the clay gages will show the thicknesses of the metal, and any alteration can be made if needed.

In very large and heavy bends the form of grid shown in previous illustration is not rigid enough, and the shape in Fig. 61, or a modified form is used. The ribs are very thin in order to facilitate the breaking-up of the grid in the casting for its extraction.

Cores made in boxes are rammed in core sand upon grids. They are rammed in each half box separately, but are cemented together before being dried. The advantage of ramming each half is that it permits of the cutting of the vent gutters in each. In cores of this kind, the grids need not be so strong as are those which are used for loam. They generally consist of a few rods bent as required, or in the larger cores, are cast iron with or without ribs or prongs. Fig. 56 is a socket pipe cored; Fig. 57 is its half core box rammed and Fig. 60 is the half cores cemented. In Fig. 57 the vent channel is seen in the joint face, and the outline of the grid is dotted. In Fig. 60 both are shown in section.

Pipes and bends are molded wholly in flasks, Fig. 59, or in the floor covered with a cope, Fig. 62. The selection of either depends almost always upon the tackle available. As a rule, it is preferable to use pairs of flasks if possible, but it is not worth while to make them specially for occasional jobs. For odd jobs, a good mold can be produced in the floor without rolling over, but with certain attendant disadvantages.

Down-Jointing Necessary

Down-jointing, Fig. 62, is necessary because of the non-coincidence of the joint face of the plain top with the pattern and mold joint. It must be made sloping at an angle of 25 to 35 degrees in order to permit of free parting without pulling up the sand. This jointing-down takes a little time and involves careful holding of the cope to prevent the sand from falling down, since it can receive no support from the stays below the joint face of the cope. It is set in place with stakes driven into the sand floor alongside lugs.

Many cores are made in sectional length, this being more convenient than sweeping a long core in one piece, which also would be nearly impracticable in some cases apart from the employment of a core box. Such is the method adopted when a long piece of straight pipe terminates in a bend or when a branch piece meets another core, Fig. 58. Then the straight portions are struck on bars and abutted against the bend, or against the straight portion. This illustration shows the lower portion of a tee-pipe molded in the floor, with the slopes of the down-jointing and squares of paper *a a*, laid against edges to check the coincidence of top and bottom, as explained previously.

Completes Reorganization

Reorganization of the Bronzbraswyt Metals Co., Pittsburgh, has been completed and the company hereafter will be known as the Pittsburgh Bronze Casting Co. The new company, which is capitalized for $50,000, received its charter Feb. 16. It will remain at its present location, 4901-11 Butler street, Pittsburgh. Carl P. Seyler, vice president and general manager of Hubbard & Co., is president of the reorganized company. John T. Seyler is vice president and Carl J. Seyler, is secretary-treasurer.

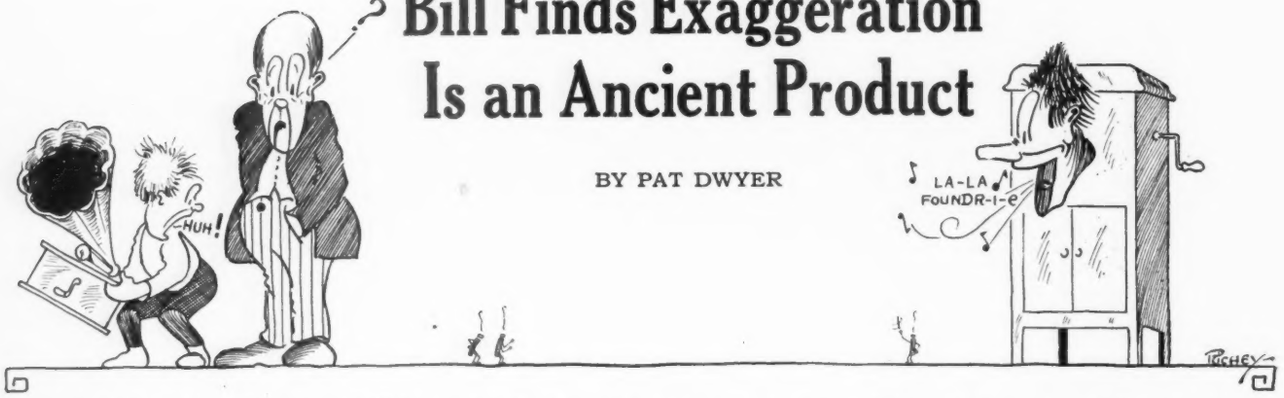
Holds Annual Exhibit

Pratt Institute, Brooklyn, held its annual exhibit of the work of the evening classes, Thursday evening, March 11. Pratt Institute is one of the pioneers in the field of industrial training and its work has been studied with interest by administrators of educational work not only in this country but in foreign countries as well. There has been an unprecedented demand for admission to its evening classes this year. Its evening department embraces courses in industrial electricity, practical electricity, technical chemistry, mechanical drawing and machine design, strength of materials, stationary steam engineering and power plant operation, marine steam engine operation, internal combustion engine work, machine work and toolmaking forge work, foundry practice, wooden boat and shipbuilding, roof framing and stair building.

W. M. Huston and E. Pester of Dayton are heading the Xenia Foundry & Machine Co., capitalized at $50,000, to erect and operate a foundry at Xenia, O., having a capacity of six or eight tons a day. The preliminary work has been completed and it is expected that production will commence about May 1. Mr. Huston has spent several years in production and purchasing work with well known firms, in different parts of this country and Mr. Pester has been engaged in the foundry business for 30 years, the last three in charge of the foundry of the Barney & Smith Car Co., of Dayton, O.

Bill Finds Exaggeration Is an Ancient Product

BY PAT DWYER



"SAY," said Bill to me, "did you ever notice the funny way kids jumble up information in their minds, without any rhyme or reason and with odd unrelated topics strung together?"

"Sure," I said, "millions of times, but I have also met grown people who had the same gift. I might go further and say that I have met people who jumble up the questions they ask so that it is impossible for the party of the second part to tell what they are driving at without asking about a dozen questions in return. Now f'rinstance what was on your mind when you asked that first question?"

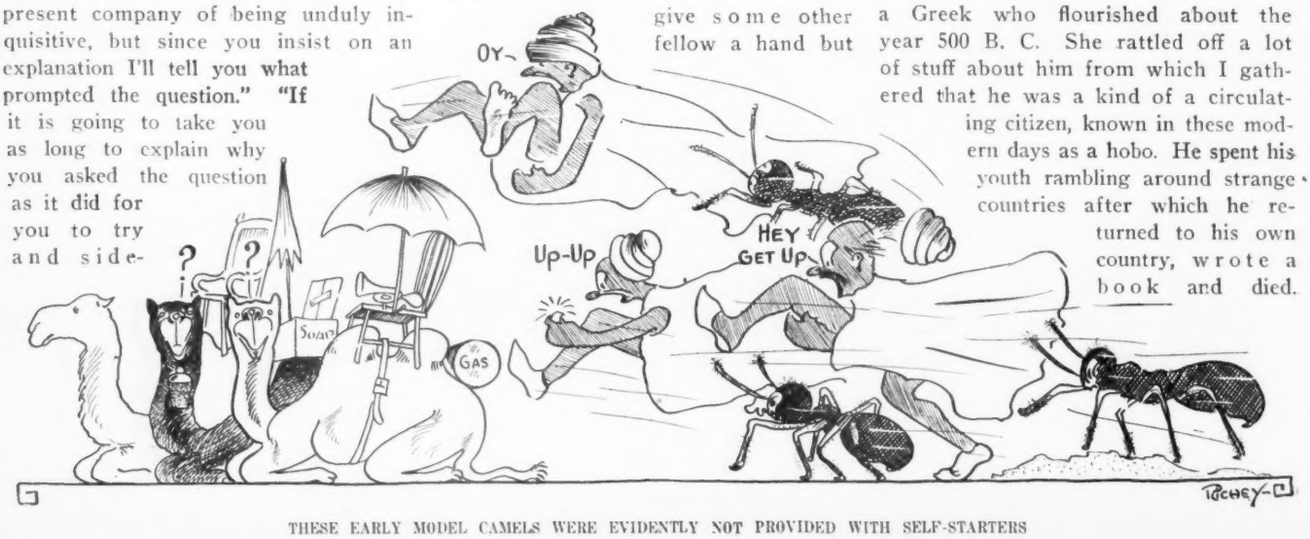
"Well," said he, "I have met some nosey individuals in my time, not mentioning any names. You can't ask them the simplest question but that they want to know the why and the wherefore, the how and the whither. They regard every question with suspicion and every questioner with distrust. They expect a man to furnish a key and a chart, a list of synonyms and an alphabetical index to say nothing of a birth certificate and a copy of the naturalization papers in the case of those bearing non-Puritan names. Far be it from me to accuse present company of being unduly inquisitive, but since you insist on an explanation I'll tell you what prompted the question." "If it is going to take you as long to explain why you asked the question as it did for you to try and sidetrack the important issue of your conversation," I said, "I might just as well throw the switch and let you out on the main line."

"I never drove a railroad locomotive," said he, "but I have poured many a ladle of steel with a locomotive crane and that is no cinch in a crowded open hearth. I should like to tell you of some of the experiences I had in that place, dodging hot metal ladles, shunting cars of slag out of the way, trying to get coal and water when every door was blocked with a train of red hot ingot molds, stranded on the main line along side a train of ingot molds being poured from a 50-ton ladle with a leaky stopper and a hundred and one adventures of a like character. However, my middle name is consistency so I will give her the steam and run down the straight high-dry line and tell you in as few words as possible just what was the motive which prompted my question."

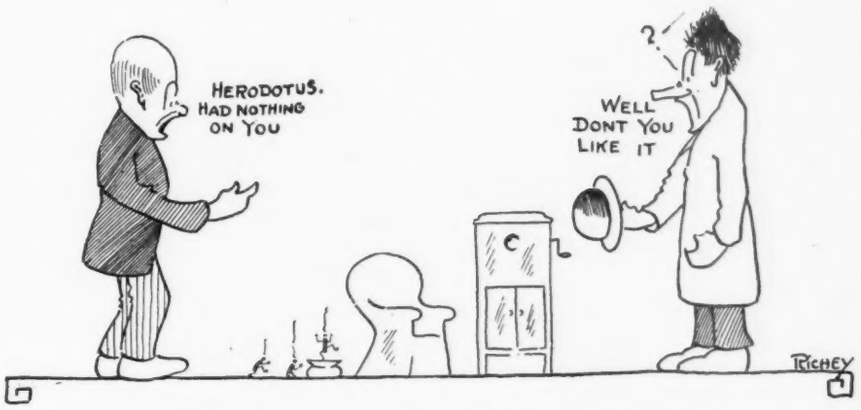
"Judging from the head of steam you are carrying now," I said, "you had better take a look at your safety valve. If she does not pop soon you'll blow up."

"Don't you worry," said he, "I may leave the job once in a while to give some other fellow a hand but I'll get the cope on before the bottom drops. I asked if you had ever noticed the way kids jumble information in their mind and fully intended following up the question by relating the series of circumstances which led up it, but you butted in with your exhibition of superior wisdom so I just kidded you along until you did not know whether I was telling you something or just talking to pass away the time. Now if you will kindly cock your long ears and cease braying I will take up the narrative and continue.

"One of my little girls climbed up on my knee the other night and asked me if I knew Herodotus. I said that as far as I knew I had never met any party by that name. 'That's funny,' said she, 'Our teacher told us today that he was a great traveler and I thought you might have met him. You were a traveler when you were young, were you not, Paw,?' I modestly admitted that I had been in a few places but perhaps this guy Herodotus did not carry a card and so I missed meeting him. Her sister who is a 9 B and therefore knows all things and from whom nothing whatsoever is hidden, kindly interrupted us to say that Herodotus was a Greek who flourished about the year 500 B. C. She rattled off a lot of stuff about him from which I gathered that he was a kind of a circulating citizen, known in these modern days as a hobo. He spent his youth rambling around strange countries after which he returned to his own country, wrote a book and died.



THESE EARLY MODEL CAMELS WERE EVIDENTLY NOT PROVIDED WITH SELF-STARTERS



A PROPHET IS NOT WITHOUT HONOR SAVE IN HIS OWN COUNTRY

"It is funny the way things happen, I had never heard of this bird Herodotus before, yet the next day I heard of him again. I was speaking to a friend and he said he had something to show me. I don't know where he got it but he gave it to me. Here read it for yourself and tell me what you think of it."

He handed me the clipping and I read the following extraordinary account of gold mining in India as described by Herodotus:

The way in which the Indians get the plentiful supply of gold which enables them to furnish year by year so vast an amount of gold dust to the king, is the following: Eastward of India lies a tract which is entirely sand. Here in this desert, there live amid the sand, great ants, in size somewhat less than dogs but larger than foxes. The Persian king has a number of them which have been caught by hunters in the land whereof we speak. These ants make their dwelling under the ground, and like the Greek ants which they much resemble in shape, they throw up sand heaps as they burrow. Now the sand which they throw up is full of gold. The Indians when they go into the desert to collect this sand take three camels which they harness together, a female in the middle and a male on either side, in a leading rein. The rider sits on the female camel, and they are particular to choose for the purpose one that has recently foaled; for their female camels can run faster, and they bear burdens much better.

Therefore, when the Indians have thus equipped themselves, they set off in quest of the gold, calculating the time so that they may be engaged in seizing it during the most sultry part of the day, when the ants hide themselves to escape the heat. When the Indians reach the place where the gold is found, they fill their bags with the sand and ride away at their best speed. The ants scenting them, as the Persians say, rush forth in pursuit. Now these animals are, they declare, so swift, that there is nothing in the world like them. If it were not, therefore, that the Indians get a start while the ants are mustering in columns of fours, not a single gold gatherer could escape During the flight, the male camels, which are not so fleet as the females, grow tired and begin to drag, first one and then the other; but the females recollect the young which await them at home and never give way. Such, according to the Persians is the manner in which the Indians get the greater part of their gold.

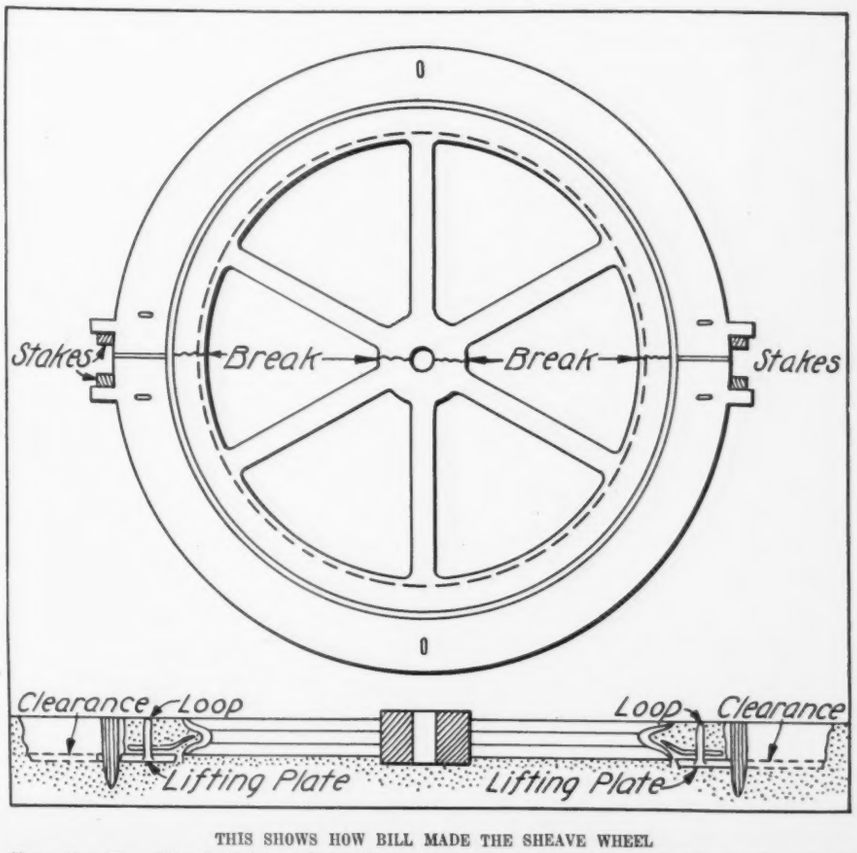
I handed the clipping back to Bill and told him he ought to be arrested for carrying that kind of literature on his person.

"Well," said he, "I'll tell you. When I heard of him first, what a great traveler he was and all that kind of thing I experienced regret that I had never met him; but after I had read that chapter about the big bull ants I felt no further regret. Herodotus is dead and we shall never see his like again, I hope, but I have met some men who must have been lineal descendants of his.

"I went down to Elizabethport one time in company with a veteran sand artist. He had been there several times before but this was my first trip. You should have heard him talking about the size and ferocity of the mosquitoes which infest that part of the country. According to his statement they used to gather around the boarding house door in the morning and accompany the men down as far as the fence around the pump shop. They would sit on the fence all morning and bark like dogs when they saw the men coming out at noon. There were several varieties of them at the port but the most vicious kind could be recognized by a yellow band around their middle. He assured me that whenever the cleaning room door was left open it was a common sight to see a company of them fly in, appropriate one of the emery stones and sharpen their bills.

"I did not stay at the port long enough to verify these blood curdling statements but I made an interesting job while there and any time now when the name of Elizabethport comes up it reminds me of a broken sheave wheel and not of a mosquito.

"A broken 6-foot sheave wheel was



THIS SHOWS HOW BILL MADE THE SHEAVE WHEEL

Upper view—The pattern bedded in and the lifting plate in place—Lower view—Mold after removing cope and digging out the trench behind the lifting plate

brought into the shop one day and the customer wanted a new one in a hurry. We made a level bed that night and cast two half circular lifting plates, the inside diameter corresponding to the outside diameter of the wheel. Each plate was provided with three lifting hooks, one near each end and one in the center. Next day the old casting was bedded in the floor and a flat parting made around the lower rim. The plates were set on this parting, facing sand spread on and a row of rods, resting on the plate and projecting into the groove of the wheel, laid all around the circumference. Sand was rammed all around until it had reached the top rim when it was struck off level and a parting made. A parting was also made at the center line of the arms at the same time. Then a cope was put on, rammed, taken off, turned over and finished. A trench was dug in the floor about a foot wide and immediately back of the lifting plates. The crane was hooked on to the three lifting hooks in one of the plates and a strain brought on by a set of turnbuckles. Then the plate was backed away from the casting bringing the sand forming the groove away with it. When it was backed away far enough to clear, it was lifted out, set down on blocks and patched wherever it was necessary. The other half was treated in the same manner. The broken casting was then taken out of the sand and the mold made up and finished. The lifting plates were replaced and the trench back of them filled with sand and rammed. Then the center core was set and the cope lowered into place. The mold was weighted and cast and as nice a casting produced as if it had been made off a pattern with a piano finish. Of course it was ¾-inch less in diameter than the old wheel but that made no material difference in this case."

"Herodotus may have been some traveler, Bill," I said, "but he had nothing on you, you have been in Greece, Persia, India and Elizabethport in the course of the last half hour and that's going some."

Production of Domestic Magnesite Grows

ALL of the refractory magnesite used in the United States before August, 1914, was imported from Austria. When the source of foreign supply was cut off by the war the companies which supplied refractory materials turned their attention to the development of domestic deposits. The known deposits of California were first exploited and in 1917 the Californa annual production reached its peak of 211,000 tons, figured as crude ore. This with a smaller output from Washington of 105,000 tons practically met the entire demand from the country. In the meantime the deposits at Chewelah, Wash., had been recognized as the most important reserve of magnesite ore in the United States and development work had been begun, but shipments prior to 1917 were a negligible quantity.

Magnesite from California and Washington as mined and calcined in the usual way, could not be satisfactorily substituted for the Austrian refractory magnesite for use in basic open-hearth steel furnaces or for the manufacture of magnesite brick. However, it was found that a suitable material could be made by combining the magnesite with oxide of iron in the presence of heat.

The Northwest Magnesite Co., San Francisco, owns a large deposit of crystalline magnesite near the town of Chewelah, Stevens county, Wash., about 60 miles north of Spokane. The mineral is found on the top of a sharp ridge in the shape of massive beds in a sedimentary series of dolomite, shale and quartzite into which igneous rocks have intruded. A large area of the deposit has been gone over and diamond drilled to a depth of 300 feet. Data have been obtained in this way for classifying the ore body into different sections depending on the lime and silica content. About one million tons of high grade ore thus far have been explored by drilling.

At the present time the bulk of the ore is taken from an open quarry near the top of the ridge whence it is lowered by an aerial tramway to a crushing plant near the foot of the hill. Here it is reduced to 2-inch size and then carried by another aerial tramway a distance of 5 miles to storage bins having a capacity of 800 tons or enough to keep the plant busy for 24 hours.

The ore is taken from the storage bins and passed through a set of rolls. The final product of this reduction all will pass through a 10-mesh screen and about 20 per cent will pass through 100-mesh screen. The proportion of this fine material is important for it assists materially in the reaction taking place between the oxide of iron and the magnesite in the rotary kilns. The pulverized ore is weighed out in batches of one ton and about 40 pounds of finely pulverized high grade magnetic iron ore (oxide of iron) is added to it. The two materials are passed into a rotary mixer which effects a thorough incorporation, and then are taken by elevator and conveyor to the small storage bins at the head of each of the five rotary kilns.

The kilns are each 125 feet in length, by 7 feet 6 inches in diameter, lined throughout with a 9-inch wall of fire brick. The five kilns have an approximate daily capacity of 300 tons. The incandescent deadburned magnesite issuing from the kilns in a continuous stream is passed through revolving steel tubes where it is cooled by air currents and is then passed through crushing rolls and sorting screens which deliver it to the sorting floor. It is then known as grain magnesite.

From a booklet entitled "Magnesite" published Oct. 1919 by the Northwest Magnesite Co., San Francisco.

Fire Damages Foundry

Fire of unknown origin seriously damaged the main building of the Collinwood Foundry Co., Waterloo road, Cleveland, March 16. The plant office building, pattern shop and a small storage building also were reported damaged. The losses aggregated between $30,000 and $40,000.

Claim Chromium in Steel Is Rust Resisting

William J. Grace, United States consul stationed in England, recently sent to the bureau of foreign and domestic commerce a report on a new kind of steel obtained by modifying stainless or rustless steel hitherto used solely for knife blades. A process now being used extensively by steel makers of Sheffield, Eng., he said, results in a product containing a larger percentage of chromium than is contained in ordinary carbon steel. The chromium renders the steel resistant to oxidation. When highly polished it resists the corrosive action of acids such as vinegar and orange juice and therefore is especially suitable for use in the manufacture of cooking utensils. British manufacturers are able to sell it at about 49 cents a pound.

Electrical Melting of Alloys - III

Various Different Types All Depending upon the Principle of Heating Metals within Crucible Containers Have Been Tried — Merits and Shortcomings of Principal Types Are Outlined

BY H. W. GILLETT

ALMOST all of the earlier experimenters in the field of electric nonferrous furnaces started their work on the crucible type unit. They looked at the ordinary coke-fired pit furnace and said to themselves, "I can develop heat around that crucible by passing a current through that coke instead of burning it." They they tried it. When they started out on a small scale, as most of them did, it worked fairly well. If a laboratory has electric power available at the low voltage and high current required by an electric furnace in which the heat is generated by passing current through a resistor of crushed coke or granular carbon or graphite, the easiest way to take off a single small melt is to embed a crucible in the resistor, heat up its contents, pull out the crucible and pour. It sounds quite simple. However, in pulling the crucible, the resistor becomes disarranged, so that it is not easy to take off a second heat. Therefore, the next step was to make a tilting crucible furnace out of it, to avoid pulling the pot out of the resistor. The hotter a resistor of carbon or graphite becomes, the less is its resistance. If any spot in the resistor starts to get hotter than the remainder, through nonuniform packing of the grains, the resistance of that spot drops, more current flows through it, and then it becomes still hotter. Soon that spot is so hot that it melts the fireclay binder of the graphite crucible; the crucible develops a hole; the metal runs out into the resistor; and the experimenter sees that he must adopt some different arrangement.

He then interposes a wall between the resistor and the crucible to keep the resistor away from the crucible, or he changes his resistor from a granular one to a solid one. In either case he may make the furnace lift-out or tilting. Consider first, the lift-out furnaces.

If a granular resistor is utilized, a retaining wall between resistor and crucible is required and heat has to be forced through this wall, through an air space (to give room for the tongs, or clearance for the crucible, if the crucible sets upon a pedestal, raised through the furnace bottom) as well as the walls of the crucible itself. Therefore, the thermal efficiency, which is low anyway because a crucible furnace has a great wall area through which to lose heat in comparison with its capacity, is lowered. The power consumption per ton of metal is high. Crucibles and their cost still are pres-

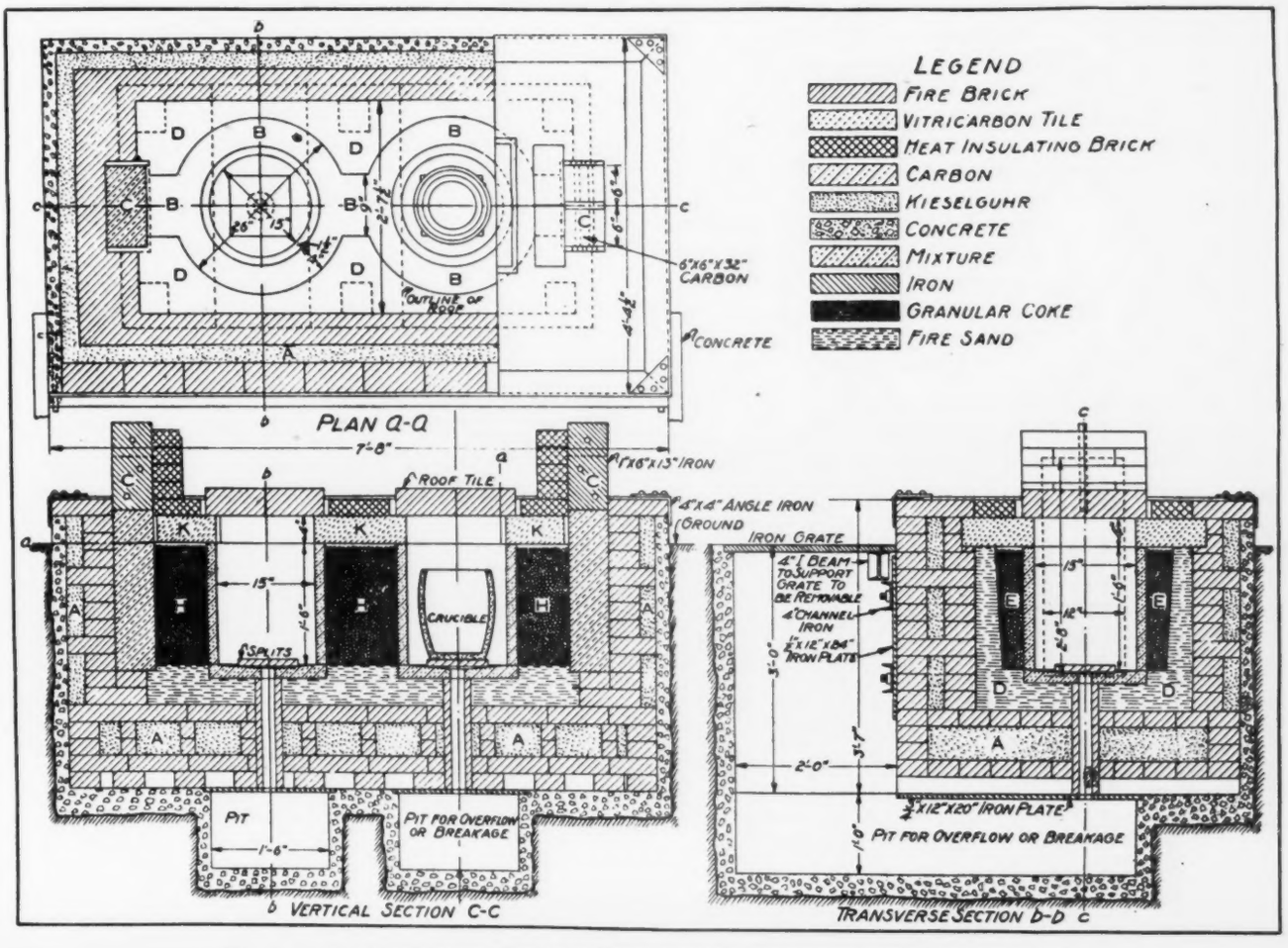
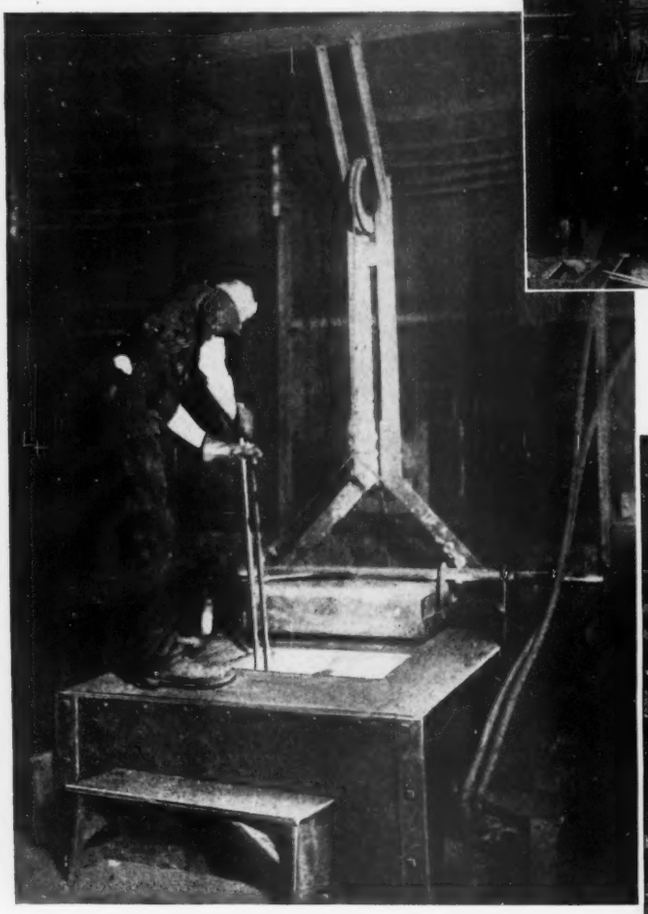
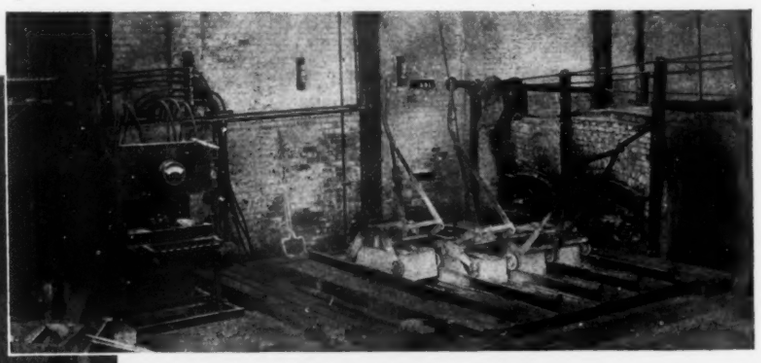


FIG. 1—GRANULAR RESISTANCE TYPE OF ELECTRIC FURNACE FOR MELTING COPPER AND ITS ALLOYS

ent. The unit of capacity is low and the labor cost high. For these reasons, although the furnace can melt any sort of brass or bronze, and can hold the metal losses down, because the furnace can be closed to keep zinc in and air out, yet the saving on the metal losses hardly balances the extra cost for electric power over fuel. The upkeep and repair cost is high because of the tendency of the granular resistor to develop hot spots. The larger the furnace is made, the harder it is to keep it in operation.

Vickers* describes a small furnace built as outlined, tried out at the Titanium Bronze Co., Niagara Falls, N. Y., and concludes that "some other form should be devised." This is shown in Fig. 1.





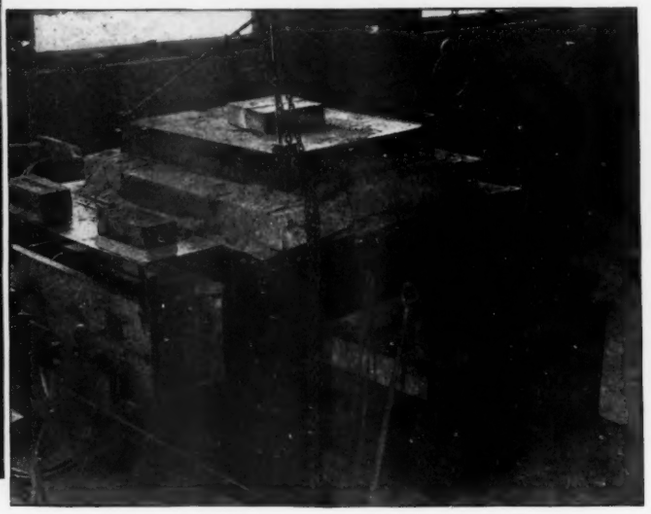


FIG. 2—AT THE LEFT—SMALL CRUCIBLE-TYPE RESISTANCE FURNACE USED FOR MELTING SILVER FIG. 3—ABOVE—LARGE MULTIPLE-PIT, CRUCIBLE-TYPE RESISTANCE FURNACE USED ON BRASS MELTING FIG. 4—BELOW—CRUCIBLE-TYPE FURNACES USED FOR MELTING BRASS

The only granular resistor, crucible lift-out furnace in actual commercial operation is a Baily furnace, rated at about 40 kilowatts, and taking two crucibles each holding 500 ounces of silver. This was installed at the plant of William A. Rogers Co., Ltd., Niagara Falls, in 1914. This is shown in Fig. 2. According to Miller**, about eight heats (16 pots, 1-3 ton) can be taken out in a 10-hour day, the power consumption being around 960 kilowatt hours per ton of silver and the metal loss is practically nil. Compare this with the results of a hearth-type furnace of 1000 pounds capacity operating 24 hours a day on silver at the Philadelphia mint***, which produces nine tons per day at less than 180 kilowatt hours per ton. The hearth-type furnace produces 10 times the output per hour, uses one-fifth as much power per ton, requires no crucibles, and gives a metal loss on silver of one-hundredth of one per cent. The question then arises, what will happen if we make an exceedingly large crucible furnace; can't we gain enough in thermal efficiency by mere increase in size?

That also has been tried. In 1915 a Baily pit furnace, shown in Fig. 3, was tried out at the Detroit Copper & Brass Rolling Mills, Detroit, which was about 6 x 8½ x 10 feet, and which held eight No. 70 crucibles set, in two rows of four each, between two resistor troughs on each side of the furnace, containing granular resistor carbon through which current was passed to generate heat. The furnace took 200 kilowatt. The furnace walls, roof, etc., occupied 440 cubic feet, the crucibles 10 cubic feet, and there was 60 cubic feet vacant space in the furnace. The surface area was 390 square feet.

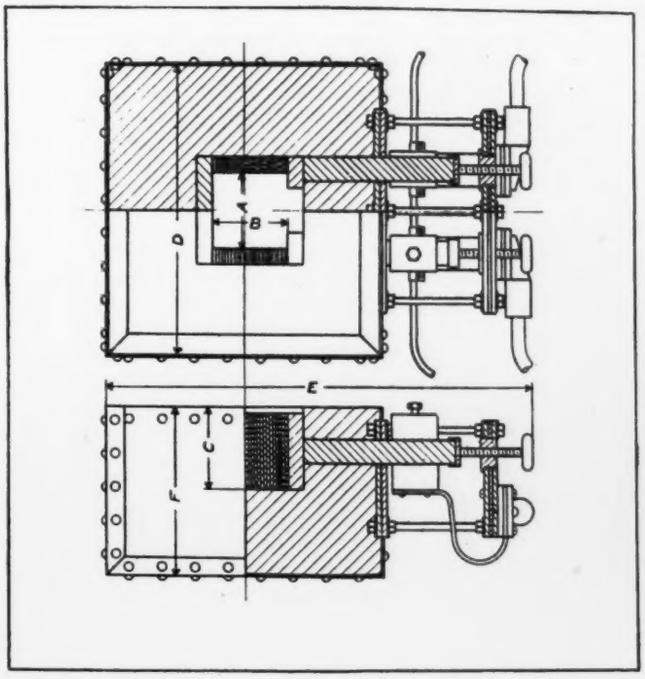
That is, there was a vast amount of furnace wall to be heated in the effort to heat the crucibles, and a large surface to leak heat. During the test, including heating the furnace several times and holding it hot while empty, over 12,500 kilowatt hours were used, and about four tons of metal were melted.

Of course the power consumption wasn't as bad as that under regular operating conditions, and the test indicated that if the furnace could be made to operate steadily 24 hours a day (and it was not designed for any but continuous operation) it might be possible to get down to 500 kilowatt hours per ton on a 60:40 brass. At this rate the 200 kilowatt furnace would produce about 9½ tons per day. Under similar conditions 24-hour operation on yellow brass, with no delays, the American

*Vickers, C., The Electric Furnace as a Copper-melting Medium, Foundry, Vol. 45, 1917, p. 280.

**Miller, D. D., The Electric Furnace for Heating Non-ferrous Metals, Jour. Am. Inst. Metals, Vol. II, 1917, p. 283.

***Baker, R. T., Annual Report of the Director of the Mint for the Fiscal Year ending June 30, 1919, p. 12.



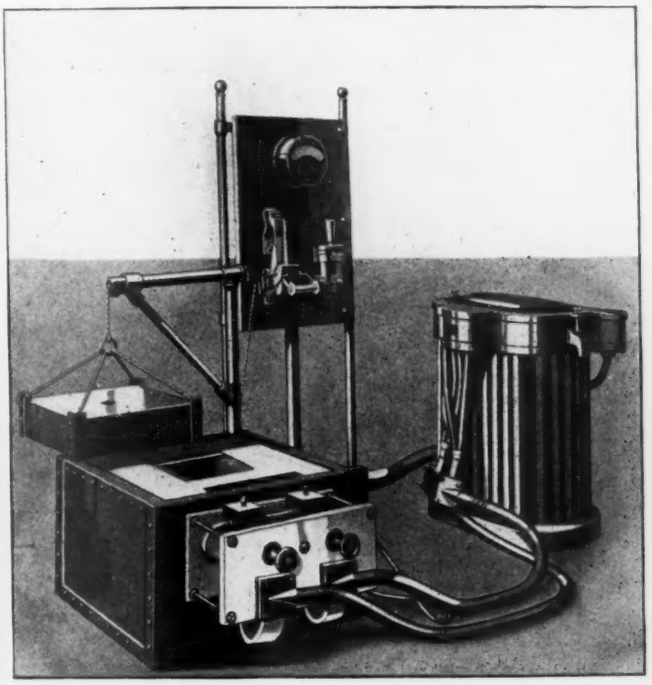


FIG. 5—DETAILS OF RESISTANCE TYPE FURNACE SHOWING THE CARBON PLATES USED AS RESISTORS FIG. 6—SMALL SIZE, CRUCIBLE-TYPE FURNACE USING PLATE RESISTORS

Brass Co. is now melting in noncrucible furnaces at 175 kilowatt hours per ton, and 200 kilowatt connected to those furnaces will produce over 25 tons per day. However, the big crucible furnace, with all the crucibles in the one enclosure threw up so much heat into the furnace tender's face when he tried to pull the pot that operating the furnace was difficult. If one pot was spilled or got overheated before it was pulled, the whole furnace was filled with zinc fume, and the crucibles could not be seen when the operator tried to pull them. Everyone who watched the test had brass shakes, and the furnace tender did not have the cool, pleasant pastime he is supposed to have from the theory of an electric furnace. The furnace was not practical nor efficient.

One other type of crucible lift-out furnace has been tested on brass. This is the Hoskins furnace, which was evolved by A. L. Marsh*, of the Hoskins Mfg. Co., Detroit, and for a long time was used by that firm, in small

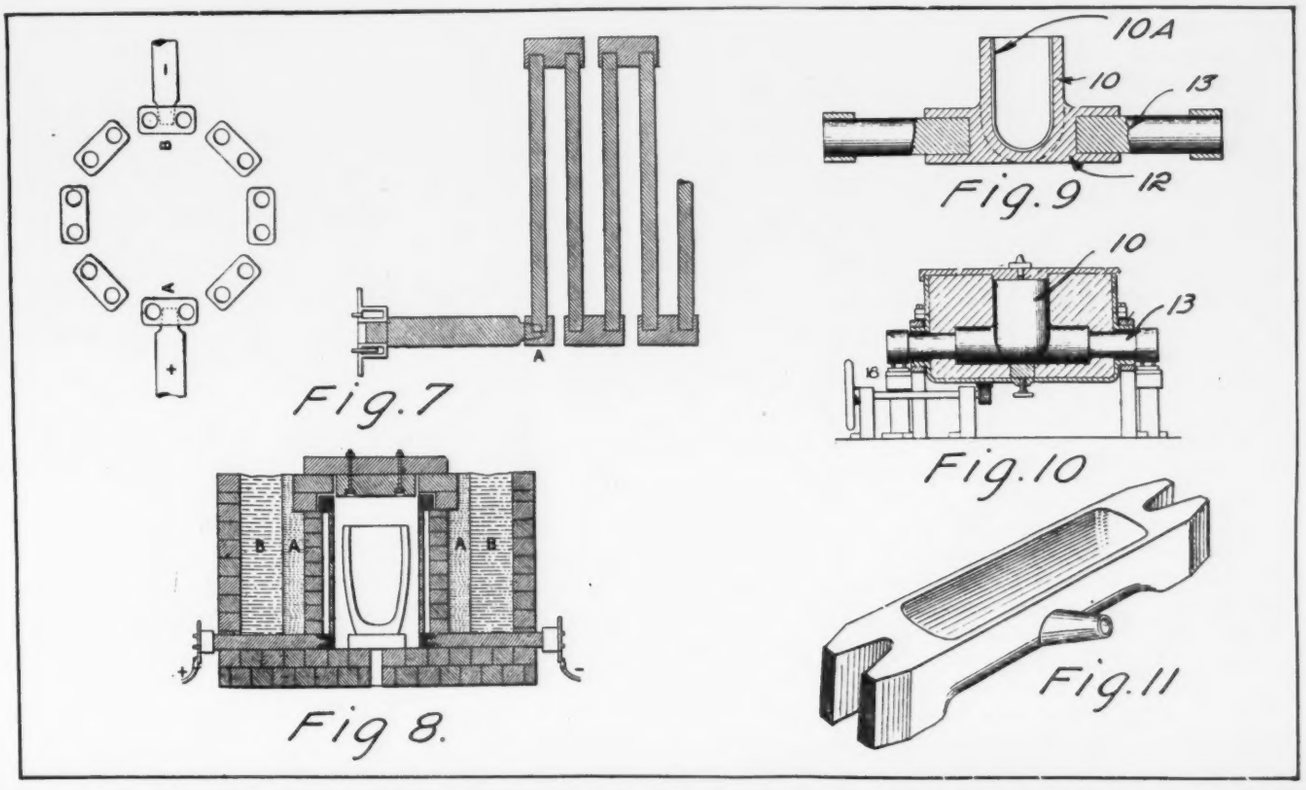


FIG. 7—DETAILS OF RESISTORS USED IN THE GREENWOOD & HUTTON FURNACE FIG. 8—INTERIOR DETAILS OF THE GREENWOOD & HUTTON FURNACE FIGS. 9 AND 10—CONLEY, CRUCIBLE-TILTING TYPE FURNACE FIG. 11—RESISTOR CRUCIBLE OF MORGAN TILTING FURNACE

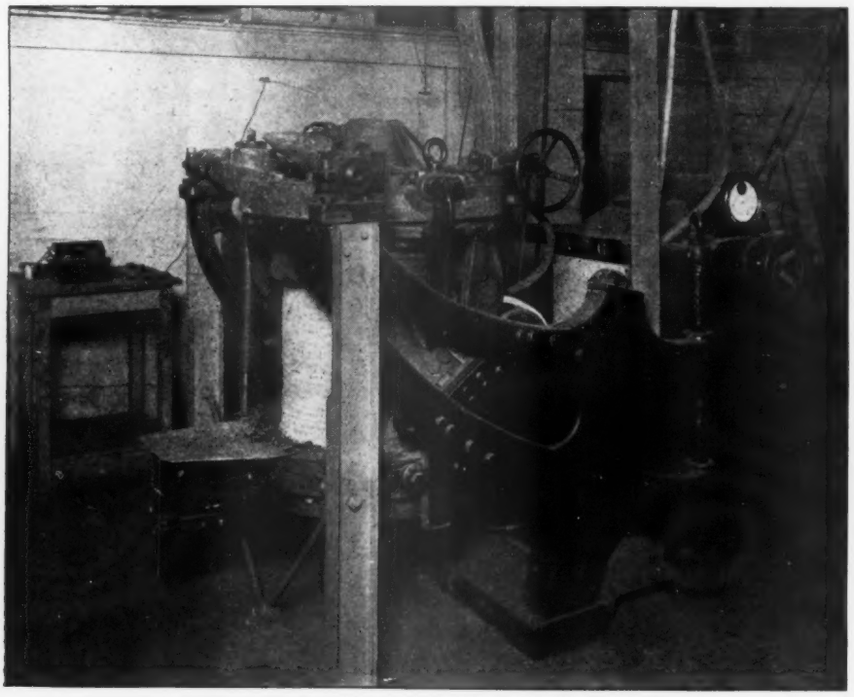


FIG. 12—HELBERGER CRUCIBLE TILTING FURNACE OF GERMAN DESIGN

sizes, for melting its nickel-chromium alloys for resistance wire, thermo-couples, etc., until it was superseded by larger hearth-type furnaces. A variety of sizes and modifications of this type was tested by the buerau of mines in its study of the possible reduction of metal losses in the eletcric melting of brass, and one taking a No. 70 crucible, shown in Fig. 4, was tested on brass, first at the Hoskins company's plant, and later, in 1915, by the Commonwealth Edison Co., Chicago, at the foundry of the L. Wolff Mfg. Co. About 17 tons of brass were melted in this last test.

Carbon Plate Resistors

The Hoskins furnace does not use a granular resistor, but instead passes the current through a pack of thin carbon plates, placed together like a deck of cards standing on end. There is a great deal of contact resistance between the surface of the plates and the resistance of the pack depends on how tightly they are squeezed together. As the carbon plates heat up and tend to draw more power, if the compression on the plates is made less, the resistance can be increased. Hence, by varying the degree of compression of the pack, the power input to the furnace may be regulated to quite a large extent, so that the furnace transformer does not require so many different voltage taps as is required on a granular resistor furnace. In Fig. 3, note the 10 different places below the meter on the switch-board of the granular resistor furnace where the switch can be put to give different voltages.

The plate compression in the Hoskins furnace is adjusted by turning the handles of screws which move the graphite electrodes that carry current to the plates. These handles are visible in Fig. 4, and more clearly shown in Figs. 5 and 6. Fig. 6 shows a smaller type of furnace in which the two rows of plates are in parallel instead of in series, as in the No. 70 crucible size. In Fig. 6 one row of blades is visible through the opening above the crucible chamber.

Resistor Blades Replace Troughs

The use of the resistor blades, which will stand up without a retaining wall, does away with the troubles connected with the use of troughs to contain a granular resistor, but they oxidize when the furnace is opened, and have to be replaced every week or so.

In a test at the L. Wolff Mfg. Co. of the 75 kilowatt Hoskins furnace for No. 70 crucible showed that, under favorable conditions, it could melt yellow brass at 500 to 550 kilowatt hours per ton on 24-hour operation, and could produce about 200 pounds per hour or 2.4 tons per day. However, on nine-hour operation, with five hours on Saturday, it would take about 900 kilowatt hours per ton, producing only about

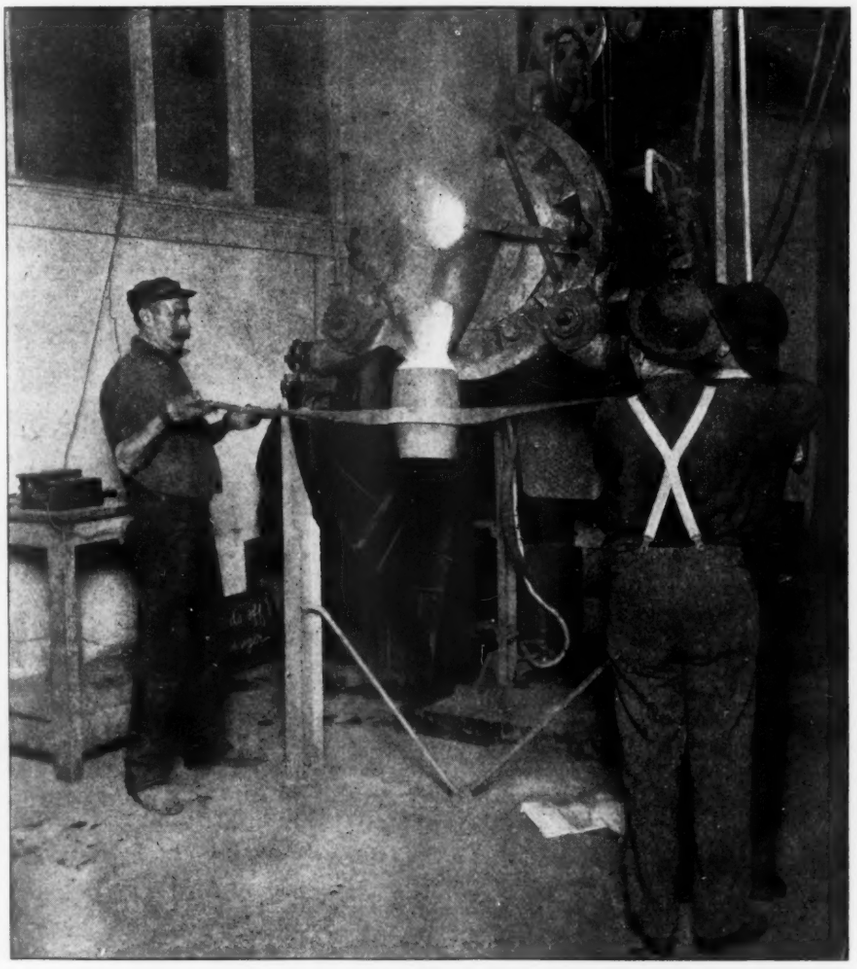


FIG. 13—HELBERGER CRUCIBLE FURNACE IN POURING POSITION

*Marsh, A. L., U. S. Patent, 882, 788.

seven heats of 200 pounds per 9-hour day, or about four tons per week. The furnace did save metal and stood up to its work fairly well. It did not appear to reduce labor cost or to give a much better crucible life. At the prices then obtaining for fuel oil and metals, the furnace broke even, in a calculation of melting costs, with the oil-fired crucible furnaces only. If the electric furnace were operated 24 hours a day, if it could get power at 1 cent per kilowatt hour, and if one considered that interest and depreciation charges were balanced by the improvement in working conditions. The furnace with complete auxiliary equipment, ready to attach to a 110 volt, 60-cycle line, was priced at about $1500 on Aug. 1, 1916, and would doubtless cost more now. The metal losses in this type of furnace were low. With a total of 3734 pounds of brass ingot containing 16 to 34 per cent zinc, melted by the bureau of mines in Hoskins' type furnace, 3713½ pounds were recovered, the net loss being 0.55 per cent. The bureau tried out, in small sizes, a modification of the Hoskins type* in which each resistor, instead of being between a furnace wall and a crucible, was between two crucibles. Instead of one crucible between two resistors, as in the Hoskins furnace for a single crucible, three crucibles were in a row with the two resistors between them. The heat generated by the resistors was then sent directly to crucibles on both sides, instead of half the heat being sent to a furnace wall. This scheme worked well in the sizes tried, lowered the power consumption per ton of metal and increased the output considerably over a furnace of the same power input taking but one crucible.

However, even with this and other improvements, it appears that the crucible lift-out type, at best, is of low thermal efficiency. The power consumption per ton is so extravagant as to overbalance the saving it can make

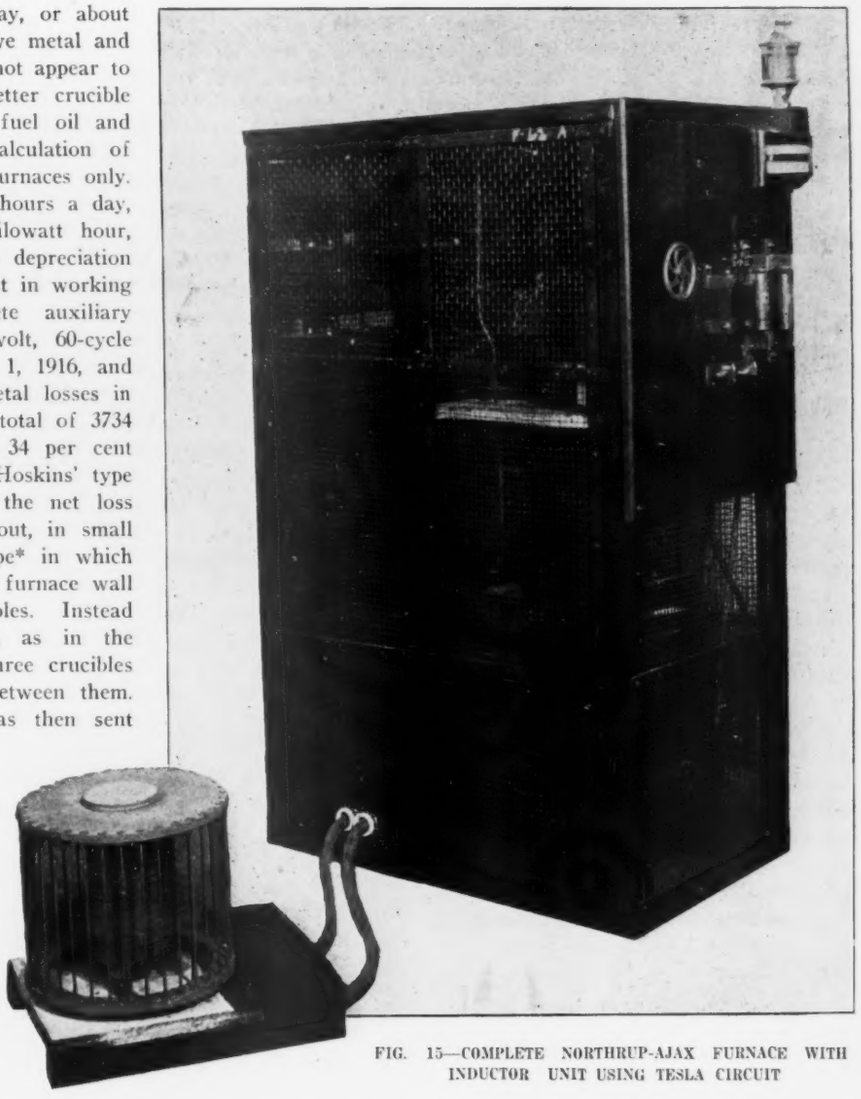


FIG. 15—COMPLETE NORTHRUP-AJAX FURNACE WITH INDUCTOR UNIT USING TESLA CIRCUIT

Greenwood and Hutton** describe an experimental crucible lift-out furnace in which a grid made up of carbon rods placed around the crucible, is used as resistor, and in which a few heats of nickel-silver (nickel brass, German silver) were made. See Figs. 7 and 8. Ninety-pound charges were used. It was calculated that the furnace would melt 450 pounds in a 10-hour day at around 750 kilowatt hours per ton, but no all-day runs are recorded. Such a resistor is too fragile and too readily oxidized to be of interest for commercial work. Weintraub*** built a crucible brass furnace of 125 pounds capacity at the Lynn works of the General Electric Co., in which a grid was used as resistor, the grid being made up of composite rods formed by casting metallic silicon about carbon rods. This protects the carbon from oxidation, and the composite rod can be made so that its resistance does not change much with change of temperature. However, cast silicon is brittle and hence the rod is fragile. Also, silicon melts at about

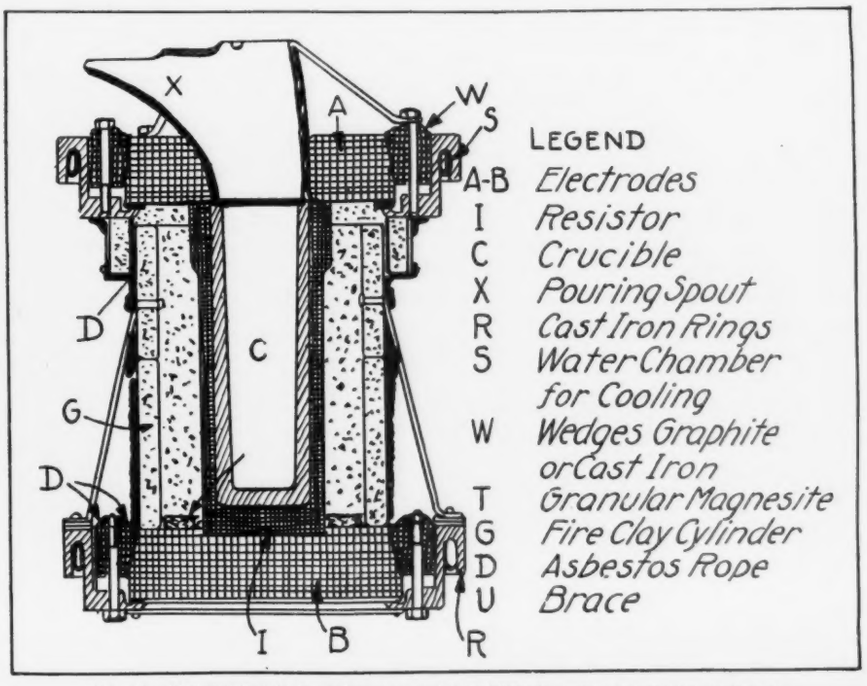


FIG. 14—CONSTRUCTION DETAILS OF THE HELBERGER TYPE CRUCIBLE FURNACE

*Lohr, J. M., and Gillett, H. W., U. S. Patents, 1162178–1162179 (dedicated to the public).

**Greenwood, H. C., and Hutton, R. S., Note on an Electric Resistance Furnace for melting in Crucibles, Jour. Inst. Metals (British), Vol. 17, 1917, p. 237.

***Weintraub, E., U. S. Patents, 1118387–1134788.

1420 degrees Cent., so that rods cannot be heated much above 1300 degrees Cent., which is too low a temperature of the heat source for an efficient transfer of heat in a furnace of this type. This furnace could be made lift-out or tilting, but the one tried was a tilting furnace.

In 1914 a Baily, crucible, tilting furnace was tried out at the Detroit Copper & Brass Rolling Mills, in which a large shallow crucible of the regular fireclay graphite mixture was supported on a firebrick pedestal. Under the crucible and around the pedestal was a circular resistor tough containing a granular carbon resistor. The crucible held 700 pounds and was expensive. It would have had to stand 100 heats to make the crucible cost per ton as low as that in the coke fired furnaces. The heat generated in the circular resistor concentrated on the inside of the trough, next the firebrick pedestal, the pedestal softened and settled, causing the crucible to crack and let metal run down into the resistor, thus bringing the test to an abrupt close. A carborundum pedestal would stand up, but the test properly discouraged the makers from locating a resistor beneath a fragile crucible. This test and that of the Baily eight-pot furnace, while failures, were of use in that they finally led to the more useful type Baily furnace, which does not use crucibles.

Contact Type More Efficient

Crucible tilting furnaces in which the crucible and the resistor are in contact, or are integral, might be expected to show a better thermal efficiency than the other types so far described. A number of these have been tried out.

Way back in 1902 Conley* applied for a patent on such a furnace, and in 1910 a furnace was tested and demonstrated to a number of brass melters. The principle is shown in Figs. 9 and 10, taken from one of the patents. The electrodes, 13, carry current to a crucible, 10, on which prolongations, 12, are molded to receive the electrodes. The crucible which is made of the regular fireclay-graphite mixture, acts as the resistor. To prevent short-circuiting of the current through the metal in the crucible, an electrically insulating lining, 10a, must be provided.

The furnace was tried out in 20-pound and 70-pound sizes. The crucible in the 20-pound size is said to have lasted 45 heats. No crucible life is given on the 70-pound, but copper was melted in the 70-pound size at something like 500 kilowatt hours per ton through the period marking the test. The whole furnace has to be dismantled when the crucible fails. The design looks to be liable to crucible failure and to consequent lack of reliability of the furnace so that no one seems to have been willing to give it a trial in commercial size. It is of interest mainly as being one of the first electric brass furnaces designed.

*Conley, M. R., U. S. Patents, 769250-989568-1023996.

Resistor Material Must be Uniform

Crucible mixture, fireclay and graphite, used as a resistor, acts like any other carbon or graphite resistor, i. e., if it is not uniform it tends to develop hot spots on account of the resistance decreasing with temperature. Hence any molded fireclay graphite resistor must be perfectly uniform if it is to stand up. This was brought out by the work of the Commonwealth Edison Co. on a crucible lift-out furnace tried out before the Hoskins furnace was tested. In this, a molded fireclay graphite cylinder slotted in a zigzag fashion to increase resistance, was used as resistor, a crucible being set inside. The resistor failed so promptly on account of hot spots that the scheme was given up as a bad job.

However, a large British crucible manufacturer, the Morgan Crucible Co.* now is advertising a molded resistor furnace of the crucible tilting type in English periodicals. Two types are mentioned, one of a regular crucible form**, much like the Helberger, the other, one in which a molded trough is used. In both, the molded resistor serves also as metal container. Fig. 11 shows the resistor of the trough style. Within this trough is a nonconducting layer to prevent the current from short-circuiting through the contents of the trough. It would require only a couple of cracks in the lining to short-circuit the resistor and render the furnace inoperative. If this sort of a resistor, made to hold a ton of metal, a size that the makers state they can supply, can be made to stand up in foundry operation long enough to make the furnace commercially available, the writer will be vastly surprised. The makers claim that the furnace in an 800-pound size will, when hot (i. e., 24-hour operation) melt 65-35 brass at 300 kilowatt hours per ton. That may be true, but the first and most vital question is, how long will it stand up before the resistor fails?

A furnace of analogous design has a resistor made of solid carbon instead of a molded fireclay graphite mixture. For this reason it is less subject to hot-spot troubles. This furnace, the Helberger has the crucible separate and replaceable instead of integral with the resistor. The Helberger, a German furnace, in a 200-pound size, was installed in 1914 by the National Cash Register Co., Dayton, at a cost of about $7500.

*See Anon. Electric Furnace Developments for Non-ferrous Metals, Metal Industry (London), Vol. 14, 1919, p. 444. Metal Industry (N. Y.), Vol. 17, 1919, p. 424.

**Speirs, C. W., British Patent 24626 of 1912.

Dorsey* has described the test quite fully. The output was about 1440 pounds in 7½ hours, the power consumption, on red brass heated to about 1225 degrees Cent., was 800 kilowatt hour per ton, and on 24-hour operation would be about 600 kilowatt hour per ton. Three crucibles averaged but 15 heats each. The long, narrow form of the crucible made it necessary for the furnace tender to stand by and feed pieces of the charge into the crucible almost constantly.

Figs. 12, 13 and 14 show the Helberger furnace. It was a typical piece of complex German mechanism. While, in tiny sizes, it might be useful for jewelers in melting up small charges of precious metals, it is not at all fit to meet American foundry conditions. The furnace at Dayton was not put into regular use. A smaller Helberger furnace was tried out in 1913 at the New York assay office for melting precious metals, but did not work well and was soon discarded.

Commercially Impractical

All the electric crucible furnaces mentioned previously have failed to show sufficient applicability to commercial conditions to enable them to get a foothold for brass melting. Many other schemes, of no more promise, have been patented or suggested. If the electric crucible furnace gets by the Scylla of lack of reliability, it is wrecked on the Charybdis of lack of thermal efficiency. It is just about as sensible to try to heat a brick house cheaply by building a fire against the outside walls instead of heating it from the inside, as it is to attempt to heat metal through a crucible wall. It is quite evident that a successful electric crucible furnace must be something radically different and its designer must get off the beaten track.

While the furnace cannot yet be classed as widely useful, a considerable degree of success has attended the new furnace of Prof. E. F. Northrup, who certainly got off the beaten track in his design. The Northrup furnace may be a crucible lift-out or a crucible tilting type, or it can be built with a permanent hearth, but its most likely form at present can probably best be classed under crucible furnaces. Adequate description of the furnace cannot be made in the space allotted to this article, since

*Dorsey, H. G., Tests on Electric Furnaces for Brass Foundries, Trans. Am. Inst. Metals, Vol. 8, 1914, p. 246.

it took its inventor 89 pages to describe the principles* on which its operation is based. The furnace utilizes the generation of eddy currents by induction from a primary coil surrounding the crucible, in a conducting mass in the crucible walls or within the crucible, when a high-frequency current passes through the primary.

The heat is generated within the metal itself, hence the furnace is thermally efficient. To get current of the necessary high frequency, 12,000 to 25,000 cycles per second instead of the ordinary 60 or 25-cycle current of common electric circuits, special generating devices are necessary.

The current mostly used in developing this furnace has been Tesla oscillatory current, obtained by stepping ordinary current up to 5000-8000 volts and passing it through a set of condensers and a special spark gap, which changes it into high frequency alternating current. This involves a considerable cost for condensers and the high voltage is dangerous to life, though the apparatus can be fairly well safeguarded. The power factor on a Tesla circuit runs from 50 to 75, i. e., is not very good, and there is considerable loss of power in the circuit outside the furnace. Even so, the apparatus is useful to the metallurgical investigator or to experimenters in a physics laboratory, as it can readily be made into a vacuum or pressure furnace. Furnaces up to 60 kilowatt have been operated on Tesla circuits.

A better source of high-frequency current is the Alexanderson alternator. such as is used in long distance wireless transmission. With high frequency current from such an alternator, many of the power losses met in the Tesla circuit are obviated, and the power factor can be made 100. The danger of a high voltage current also is avoided. The drawback is that such alternators are costly, and are not possessed by the central stations from which the brass melter buys his power.

Several Northrup furnaces have been installed by physicists for laboratory use. Baker & Co. have installed one for melting platinum. One has been installed by J. R. Wood & Sons, manufacturing jewelers, and the Philadelphia mint has ordered four for the deposit melting room. That is, the furnace is already on a commercial basis for the melting of precious metals.

Heat is Generated in the Charge

Brass melting is a somewhat different matter, but Professor Northrup's firm, the Pyroelectric Instrument Co., Trenton, N. J., is developing the furnace for, and with the financial support of the Ajax Metal Co. of Philadelphia, with brass melting as one of its ultimate objects. The furnace is called the Northrup-Ajax, the patents being owned by the Ajax Metal Co.

In a test of an 18 kilowatt furnace on copper, melting was done, using power from an Alexanderson alternator, at about 240 kilowatt hours per ton, and using Tesla oscillatory current, at about 500 kilowatt hours per ton.

Fig. 15 shows a small Northrup-Ajax furnace, using a Tesla circuit, with the high voltage transformer, condensers and spark gap in the cage, switches and meter on the end of the cage, and the furnace proper in the lower left-hand corner. The furnace shown takes a crucible 8 inches high and 4 inches in diameter, and will heat its contents to 2500 degrees Cent. (4500 degrees Fahr.). For brass the same power would of course operate a much larger crucible.

The Northrup furnace would operate almost as efficiently on a single heat per day as it would on 24-hour operation, because the furnace does not need thick walls to retain the heat, since the heat is generated in the charge itself, and the heat storage is small. It would have all flexibility as to the different alloys it can handle that any crucible furnace can have. Given the right sort of current to work on, it will use as little power per ton as almost any of the furnaces now commercially used on brass.

However, until high frequency current can be bought, much more readily and cheaply than at present, the immediate commercial utility of the furnace for melting metals seems to be confined to precious metals like gold and platinum. Whatever the future may hold for the Northrup type, there is as yet no electric crucible brass furnace, either lift-out or tilting, that appears able to displace fuel-fired brass furnaces on its merits. It is fortunate indeed that electric furnaces which do not require crucibles can produce metal of crucible quality.

*Northrup, E. F., Principles of Inductive Heating with High Frequency Currents, Trans. Am. Electrochem. Soc., Vol. 35, 1919, p. 71; Chem. Met. Eng., Vol. 20, 1919, p. 381.
Production of High Temperature and its Measurement, Met. & Chem. Eng., Vol. 17, 1917, p. 685.
Some Results Obtained in Electric Heating with High Frequency Induction. Pyroelectric Bull. No. 9, Nov. 1919.
Northrup-Ajax High Frequency Induction Furnace, Chem. & Met. Eng., Vol. 19, 1918, p. 155.
Electrical Production of Carbon-free Alloys, Chem. & Met. Eng., Vol. 21, 1919, p. 258.

How and Why in Brass Founding

By Charles Vickers

High Melting Point Alloy

We desire to obtain a formula for a copper alloy that will withstand the highest temperature. We are now using phosphor bronze.

As the melting point of copper is higher than that of tin, zinc or lead, admixtures of these more fusible metals lower its melting point. Therefore, it follows that the more copper the alloy contains the higher is its melting point. Thus a phosphor bronze containing copper, 80 per cent; tin, 10 per cent; lead, 10 per cent, and traces of phosphorus, would have a lower melting point than an alloy of copper, 90 per cent; tin, 10 per cent, with traces of phosphorus. If a leaded phosphor bronze, such as the one just mentioned, is being used it would be advisable to omit the lead and add copper in its place, should the alloy be found to be too fusible.

A more infusible alloy than ordinary phosphor bronze is the following: Copper, 65 per cent; nickel, 32.25 per cent; aluminum, 2.75 per cent. Melt the copper and the nickel together under charcoal, then add the aluminum just before pouring the metal.

Soft Brass Alloys

We are having difficulty in choosing an alloy suitable for brass castings to be used in connection with food products. These castings must be tinned, therefore, must be entirely free from all defects caused by gas, and at the same time they must be easily machined on high speed lathes.

We have tried a number of alloys, all of which were pronounced too hard. Some of these alloys follow: (1) *Copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent; lead, 5 per cent.* (2) *Copper, 90 per cent; tin, 3 1-3 per cent;*

zinc, 3 1-3 per cent; lead, 3 1-3 per cent. (3) Copper, 80 per cent; tin, 6 2-3 per cent; zinc, 6 2-3 per cent; lead, 6 2-3 per cent. The following alloys were considered as too yellow (although they are tinned): Copper, 75 per cent; remainder lead, tin and zinc. Copper, 68 per cent; remainder, tin, lead and zinc. We would be pleased to receive a formula that will fill these requirements.

The following alloy is soft and machines easily, being thus suited for small castings that must be finished rapidly: Copper, 83 per cent; zinc, 8.50 per cent; lead, 8.50 per cent. If this proves too soft, it may be hardened by the addition of tin. Thus an alloy of copper 81 per cent; tin, 2 per cent; zinc, 8.50 per cent; lead, 8.50 per cent, will be stiffer than the first mentioned alloy, and for the purpose outlined might be more suitable.

Another easily machined red brass follows: Copper, 83 per cent; tin, 2 per cent; lead, 10 per cent; zinc, 5 per cent. The latter alloy has a tensile strength of around 20,000 pounds per square inch and an elongation of from 7 to 13 per cent, therefore it is strong enough for the purpose mentioned.

Preventing Sponginess in Bronze Castings

We have experienced considerable trouble in getting sound castings in large solid bushings, which range from 3 to 5 inches in diameter. These castings are made from an alloy consisting of copper, 86 per cent; tin, 6 per cent; lead, 4 per cent, and zinc, 4 per cent. We pour the castings from the bottom and put a head about 8 inches high on top of them. After sawing off these risers we find small holes through the casting. We churned most of the castings and they came out with only small holes, while those not churned had large holes. Smaller bushings poured from the same metal were perfect. Can you suggest a remedy for this difficulty?

The trouble is caused by shrinkage. It is difficult to judge whether a head 8 inches high ought to be sufficient to feed the casting solid, unless the dimensions of the casting is known. However, in a heavy mass of bronze cast in sand molds, more metal will be required in the feeder than is contained in the casting to insure solidity, unless the casting is chilled by casting in an iron or carbon mold. A good rule to follow, is to have the metal in the riser one-third heavier than in the casting, and sometimes in the case of solid bars cast upright this allowance is hardly enough. The churning will materially assist in getting sound castings as it keeps the riser from solidifying before the casting. If the riser solidifies first, there will be holes in the casting, or the metal in its heart will be *pappy*, like the inside of an elder stick. When the outside skin of the casting is cut, no defects may be visible to the eye, but the castings will not hold pressures when subjected to the same. If these castings are straight sticks less head will be required to get them solid if they are molded horizontally and cast on an incline running the gate to the bottom end so the metal can rise slowly in the mold, and having at the upper end a riser ½ inch larger in diameter than the casting, and 6 or 8 inches high. The gate from the riser should be nearly the diameter of the casting, and should be broken off while still hot.

Close-grained Aluminum of High Tensile Strength

We are interested in the manufacture of aluminum castings for dairy utensils. The metal must be of close grain, free from pin holes, scars or flaws, and polish to a high finish. The weight of the castings is not so important as strength. We would like to get the analysis of an alloy suitable for this purpose.

As specific gravity is secondary to strength the following alloy will be found suitable: Aluminum, 62 per cent; zinc, 25 per cent; copper, 3 per cent. This alloy can be depended upon to possess over 30,000 pounds tensile strength. It will be free from pin holes, scars and flaws if carefully handled during the melting period, and if poured into the molds at a low temperature. Careful melting means that the temperature of the metal should not be allowed to rise above incipient redness. It should be poured as cool as possible consistent with running the castings, if a pyrometer is used, keep the temperature as much under 700 degrees Cent. as will run the castings. A few tests will determine the proper pouring temperature for the thickness of metal in the walls of the castings. Use high heads on the molds to get pressure, and thus run, clean, sharp castings.

Aluminum Alloys for Pressure Work

We are making aluminum kettles of 8, 10 and 14-quart sizes which must withstand a steam pressure of 25 pounds per square inch. The walls of the kettle are about ⅛ inch in thickness; the alloy being composed of aluminum 92 per cent, copper 8 per cent. We have difficulty in getting the castings to withstand the pressure, also find small pits or depressions in the metal that fail to polish out. The leakage is usually in the vicinity of the gates, and in our efforts to overcome the trouble, we have gated them in as many different ways as possible. The aluminum is melted in coke-fired furnaces under pyrometer control, the melting temperature being about 1230 degrees Fahr., and pouring temperature around 1218 degrees. We add about 1 per cent of tin, a small piece of an alloy containing phosphorous and a flux which we purchase. Any suggestions you may offer will be appreciated.

An alloy that appears to be more successful than most other aluminum alloys for castings subjected to pressure, consists of aluminum 96 per cent; copper, 2 per cent, and magnesium 2 per cent. This makes a dense and strong alloy that is easily machined. While the cost of this alloy is about 4 cents per pound higher than the regular No. 12, minus the tin and other additions, it proves much cheaper in the end owing to the larger percentage of sound castings that are obtained. In making the alloy it is necessary to procure virgin aluminum, as the remelt No. 12 found on the market cannot be used. If, however, it is desirable to continue with the present alloy exercise greater care in melting and pouring, for while the melting and pouring temperatures mentioned are correct it is possible that occasionally the aluminum may be poured above 1300 degrees Fahr., at which temperature it will not hold pressure. If the metal is "recovered" aluminum there may be something radically wrong with the alloy itself, and it would be advisable to obtain virgin aluminum, and add the copper as an alloy of half and half copper and aluminum, leave out all the flux mentioned, and also the tin, using only zinc chloride as a flux.

Sulphur Attacks Metal

Orders for molds into which hot sulphur is to be poured have been received by us. We understand that the sulphur attacks iron molds very rapidly and it was suggested we try aluminum. We would be pleased to have you advise us of any nonferrous metal suitable for these molds, which will not be attacked by the hot sulphur.

There are very few metals sulphur will not attack, and this would be accentuated after the molds become heated. We suggest the use of No. 12 aluminum, which contains 8 per cent copper and 92 per cent aluminum. Molds made of this alloy, especially if water cooled would probably last as long as those made from any commercial metal or alloy. The metal can be obtained in ingot form from any of the metal supply houses.

Long Lathe Castings Demand Skill

Chilling the Ways on the Lathe Bodies Has Proved a Preventative for the Deflection Which Is Characteristic of Long Castings — Correcting Warped Beds by Reheating

MACHINE tool manufacture is a typically American industry. By this is not meant to decry the efforts or products of other lands for there are some excellent tools turned out by foreign manufacturers; but nowhere else in the world is there such a volume and variety of machine tools made as in the United States. Most of these are absorbed by the domestic needs of the country but a considerable foreign trade has been developed in recent years. Some American cities long have been known and recognized as machine tool centers by reason of the large number of establishments located in their environs and devoted to the manufacture of these goods. There are many companies which conduct complete establishments and furnish every item of the work from the designing and making initial drawings, to the erecting, crating and shipping the finished machine. There are others, again, who do only part of the work. Included in the latter class is the Elmwood Casting Co., Cincinnati, which as the name indicates confines its efforts to producing the castings for a number of manufacturers that machine and assemble the complete units.

The main foundry building of the Elmwood company, 120 x 300 feet, is divided into three bays each of which is served by a number of cranes. One side bay houses a portion of the chipping and cleaning equipment, blowers and compressors, cupolas and core ovens. The center bay is devoted for the most part to a molding floor but a space is reserved at one end for cleaning the castings and at the other for making the cores. The third bay is provided with two jar-ram machines. This bay is used exclusively for medium sized work, that is patterns which will go into flasks that are best adapted to the size of the machines. The patterns used on this side of the shop all are fitted with suitable dowels for mounting on the various plates or boards that go on the molding machines.

SINCE this article was written the foundry of the Elmwood Casting Co., Cincinnati, was damaged by fire. In addition to the foundry building and equipment a great number of patterns owned by various machine tool manufacturers situated in and around Cincinnati were also consumed. An extension to the foundry building which was in course of construction will be rushed to completion and an attempt made to carry on until a new foundry is erected.

An additional building at one side near the end of the main foundry structure is maintained as a separate unit for the production of the smaller parts. Nearly all of the molds are made in snap flasks on molding machines of the squeezer type. The cupolas which serve the main shop also supply iron for this annex. A narrow gage track extends from in front of the cupolas to the side bay where it is used to distribute iron to the molds which have been made on the jolt machines. Turntables are provided at the necessary points so that ladle buggies may be diverted from the side bay track into the annex where all of the small molds are made. The trucks carrying the ladles are mounted on ball bearings and are pushed easily by two men to any designated point in a minimum of time. One of those in charge of the truck also manipulates the ladle for filling the hand ladles of the workmen who pour the snap flasks.

Dry sand cores always have played an important part in the molding of machine tool castings, but at no time as they do at the present. The tendency is to substitute dry sand wherever possible. As a result the coremaking department of the shops devoted to this class of work are extensive. A considerable area of the main bay and a portion of one of the side bays in the foundry of the Elmwood Casting Co. is required for making the immense quantity of cores that are needed every day. Most of the cores are chunky blocks and are made principally from a loam sand which requires a little artificial binder.

Three large ovens are provided for drying the cores and some of the molds. Each oven is 24 x 12 x 10 feet and fired with natural gas. The tracks in the ovens extend out partly across the floor of the main bay, so that the cars which are equipped with standards and cross bars for carrying four decks, can be loaded and unloaded by the

FIG. 1—BOTH WOOD AND IRON FRAMES ARE EMPLOYED FOR A CURBING AROUND THE TOP OF THE PITS—THE COPES AND FRAMES ARE KEPT ON BRACKETS ATTACHED TO THE COLUMNS SUPPORTING THE CRANE RUNWAY FIG. 2—ONE OF THE SMALLER MOLDS ASSEMBLED AND READY FOR POURING

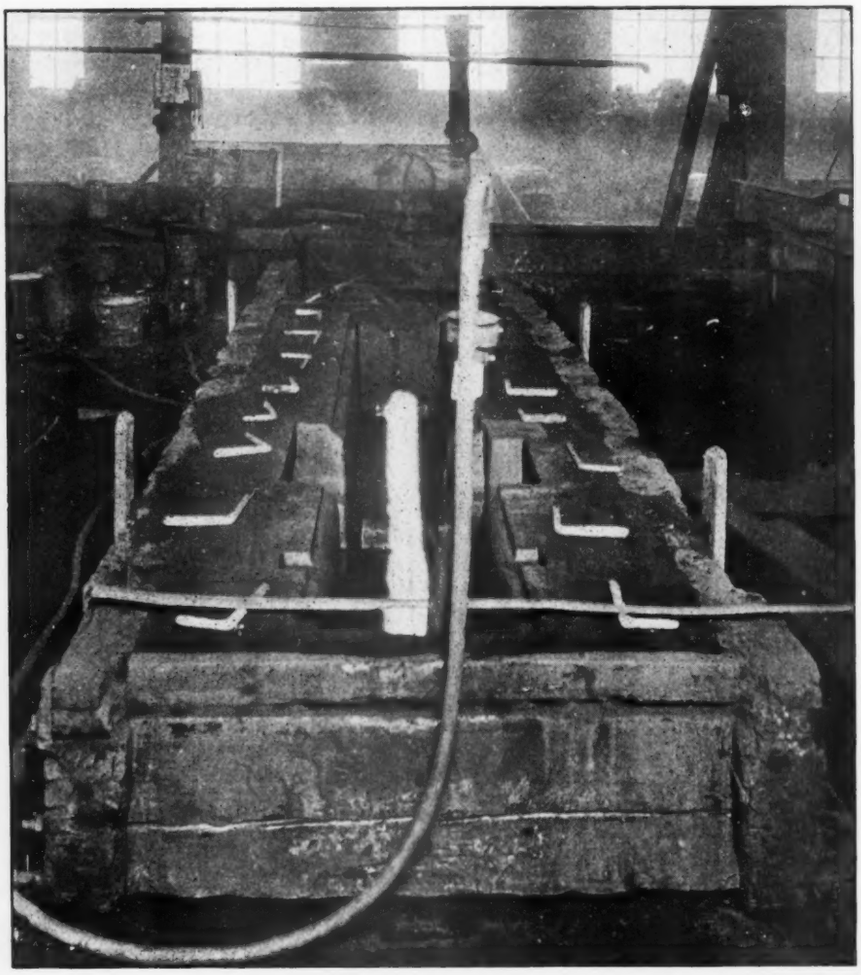


FIG. 3—NATURAL GAS BURNING IN PERFORATED IRON PIPES IS USED FOR SKIN DRYING THE MOLDS

crane. The loaded cars are pulled out in the morning and the cores are taken off by commencing at the top deck and stripping each one in turn. The cores are taken either directly to the molds or are piled in a convenient place. The cars then are gradually loaded again, the first tier of cores being loaded on the frame of the car and each deck being built up in turn. A pair of cam hooks attached to the hook of the crane is used for loading and unloading the smaller sizes of plates. The larger plates are provided with suitable lugs for attaching the regular crane chains. One of these plates with a nearly complete set of cores for the mold shown in Fig. 5 is illustrated in Fig. 6.

Great Care is Necessary

Long planer tables are made in a comparatively shallow pit such as that shown in Fig. 1. The channel beams at the ends and sides serve as a curbing for the mold and also as a guide for lining up the pattern; they also provide a solid, substantial bearing for the cope so that there will be no danger of the mold crushing when the weights are put on before the metal is poured. A coke bed is spread on the bottom of the pit to take care of the vent from the green sand bottom of the mold. The sides and top of the mold are formed in cores. When the mold is assembled it either is covered with a cope which is rammed full of sand afterward, or a number of plates are

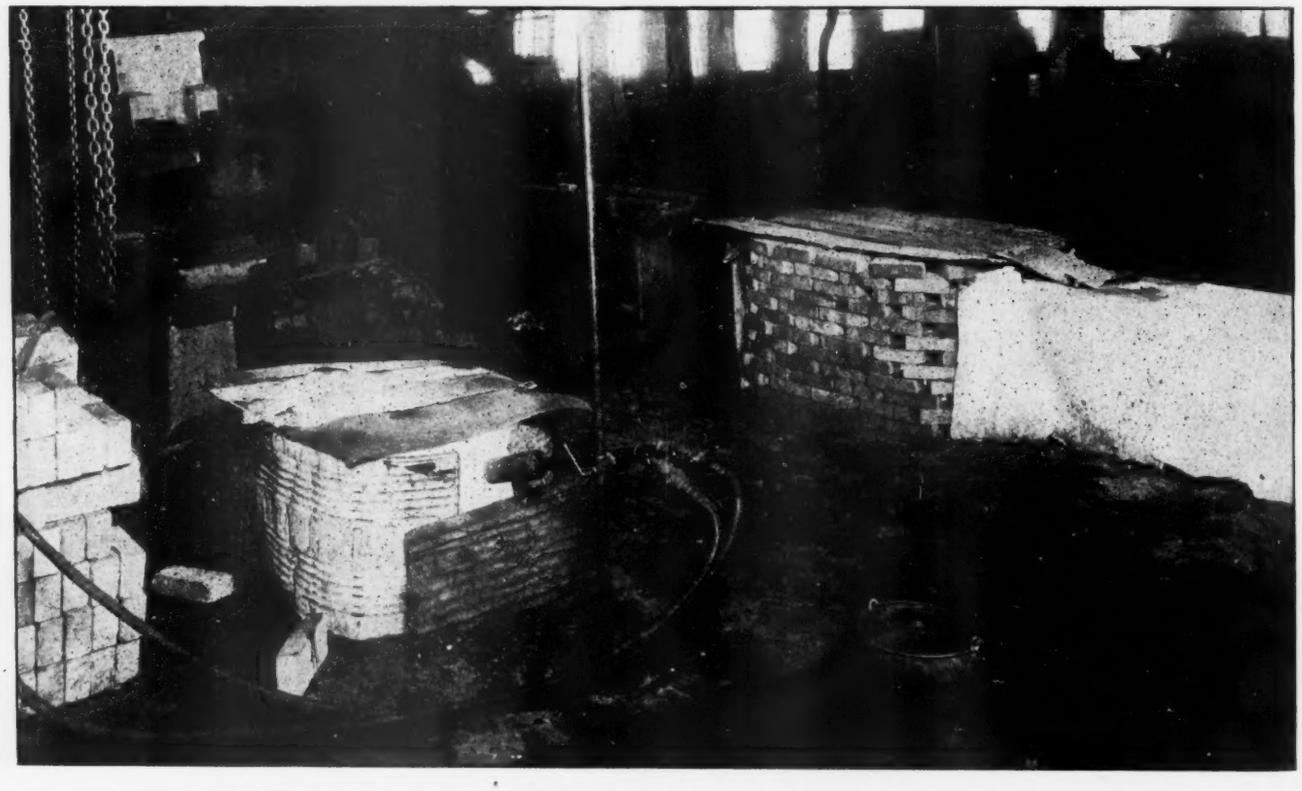


FIG. 4—CASTINGS WHICH NEED TO BE STRAIGHTENED OR WELDED ARE FIRST PREHEATED BY GAS OR BY CHARCOAL FIRE

ALLOYS OF INTEREST TO THE BRASS FOUNDER

Alloys Used in Famous Statuary

An analysis of the statue of Henry IV, Paris, France, showed it to consist of the following alloy:

	Per Cent
Copper	91.40
Tin	3.75
Zinc	4.20
Lead	0.48

An analysis of the statue of Napoleon I, Paris, follows:

	Per Cent
Copper	75.00
Tin	3.00
Zinc	20 00
Lead	2.00

It will be noted the Napoleon statue was cast of a good grade of yellow brass. This alloy is excellent for producing castings that are required to be of a yellowish color when finished, and is more easy to cast than ordinary yellow metal.

The Column Vendome, Paris, consists of a copper-tin alloy as follows:

	Per Cent
Copper	89.20
Tin	10.20
Zinc	0.50
Lead	0.10

The above was the old Vendome Column which was made by recasting captured cannon.

An equestrian statue of Louis XIV, cast by Keller in 1699 had the following composition:

	Per Cent
Copper	91.40
Tin	1.70
Zinc	5.35
Lead	1.37

This alloy is very soft, in which respect it differs greatly from an equestrian statue of Louis XV, the composition of which follows:

	Per Cent
Copper	82.45
Tin	10.30
Zinc	4.10
Lead	3.15

ALLOYS OF INTEREST TO THE BRASS FOUNDER

Alloys Used in Famous Statuary

The statue of Germanicus in Pottsdam, Germany, consists of the following alloy:

	Per Cent
Copper	89.78
Tin	6.16
Zinc	2.35
Lead	1.33
Nickel	0.27

The statue of Bacchus also at Pottsdam follows:

	Per Cent
Copper	89.34
Tin	7.50
Zinc	1.63
Lead	1.21
Iron	0.18

The statue of The Shepard, also at Pottsdam contains a little more tin as follows:

	Per Cent
Copper	88.68
Tin	9.20
Zinc	1.28
Lead	0.77

A statue of the Great Elector erected in Berlin, Germany, in 1703 was made of the following rather complex alloy:

	Per Cent
Copper	89.09
Tin	5.82
Zinc	1.64
Lead	2.62
Iron	0.13
Nickel	0.11
Antimony	0.60

The sculptor Glabenbeck used a very soft alloy. His statues of Melanchthon at Wittenberg, and of William IV at Cologne were made of the following alloy:

	Per Cent
Copper	89.55
Tin	2.99
Zinc	7.46

It is evident the individual preferences of the sculptor has had a great influence in determining the alloy to be used for his work.

THE FOUNDRY DATA SHEET, APRIL 1, 1920

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

bedded down on top of the cores. Long weights then are set on, resting on the solid floor on both sides of the mold to avoid any danger of crushing and wedges are driven between the weights and the plates. The short beds are poured from one end but some of the long ones require two and sometimes three ladles to pour them. In the latter case one runner is built at each end and one near the center at one side. Great care must be exercised in the preparation of molds for castings of this character. There are so many finished surfaces on them that the least bit of dirt would be fatal to success. The planer tables generally are cast with the flat straight face down because it is always finished all over and must present a perfect unbroken surface. The *V*-shaped bearings on which the table travels when in use are made in the cope if the pattern is designed to be molded that way; while if the system which has been coming into vogue in recent years is adopted these *V*-shaped bearings are provided for in the cores which are used to take the place of the cope. Many of these tables are simple plates connected to the bearings w t a series of longitudinal and transverse ribs and others again are made with a box section lightened out by a set of chamber cores. The sides of the mold, whether made of skin dried molding sand or of dry sand cores are provided with suitable prints to carry and support the chamber cores.

Danger of Warping Obviated

On account of the uneven thickness of metal in the top and bottom side of most of these long castings there is a decided tendency for them to warp in cooling. To counteract this tendency the mold is made with a slight dip in the center. There is no hard and fast rule for determining the amount of dip necessary. It is all a matter of judgment on the part of the foundryman. Several factors must be taken into consideration in addition to the length of the pattern. The composition of the iron exercises a decided influence on the shrinkage and contraction of castings, particularly on long castings of this character.

In making the first casting off a new pattern, the foundryman is guided by his experience in making similar work previously. The experience is not always infallible for there always are points of difference between patterns, even those which appear to be exactly similar. There have been instances where castings have sprung so far from the straight line that they had to be scrapped but if the discrepancy is not too great it may be remedied by heating the casting and pressing it back to shape.

Long castings which are to be straightened generally are supported at both ends with the convex side turned up. A fire is then built under the concave side resulting in the expansion of that side and a consequent straightening of the entire casting. Sometimes it is necessary to pile weights on the center to act in conjunction with the force operating beneath.

A more satisfactory method for performing this operation and one that is employed almost exclusively in this shop is to heat the casting while on its side and apply pressure with jack-screws at various points horizontally. For comparatively short castings, the concave side of the casting is lined up against two or more of the long, heavy, rectangular weights which are always available. A charcoal fire is then built around it until the casting is red hot. Additional weights are set on the floor a short distance back of the convex side and a number of jack-screws adjusted between the weights and the casting. Pressure is then brought to bear until the face of the casting assumes a straight line and is jammed up against the weights in front of it. The fire is allowed to die out and the jack-screws are left in position until the casting is cold. In the event one of the extremely long castings comes out of the mold warped, it is treated in the same way with the exception that instead of using weights to hold it in front, it is held in position against two of the columns which help to support the roof. Weights are used as in the former case to provide a purchase for the jacks.

FIG. 5—THE OPEN END OF THE MOLD WILL BE CLOSED WITH A DRY SAND STOP-OFF CORE—NOTE THE TWO ROWS OF CAST IRON CHILLS IN THE BOTTOM OF THE MOLD WHICH FORM THE WAYS OF THE LATHE

Even Metal Thickness Necessary

Few castings in this shop require to be straightened. Precautions taken in designing the patterns, in equalizing as far as possible the metal thickness, in providing iron of a suitable analysis and in observing some peculiarities in molding practice usually result in castings that are perfectly straight.

One of the principal features to be observed in the production of homogeneous castings is to have as nearly as possible an even metal thickness. When passing from the liquid to the solid state the transition takes place uniformly and there will be no segregation at the points where thin and thick sections meet. The castings will cool evenly all over and there will be no distortion on account of one side cooling before the others are pulling it out of shape.

A suitable iron for lathe beds and similar castings having an average metal thickness of 1 inch is: Silicon 2.00 per cent; sulphur about 0.10 per cent; phosphorus 0.60 per cent; and manganese 0.70 per cent. The cupola charges are made up in the proportion of half and half pig iron and scrap. Steel is added to the charge in varying proportions from 10 to 30 per cent.

The lathe beds generally are made in

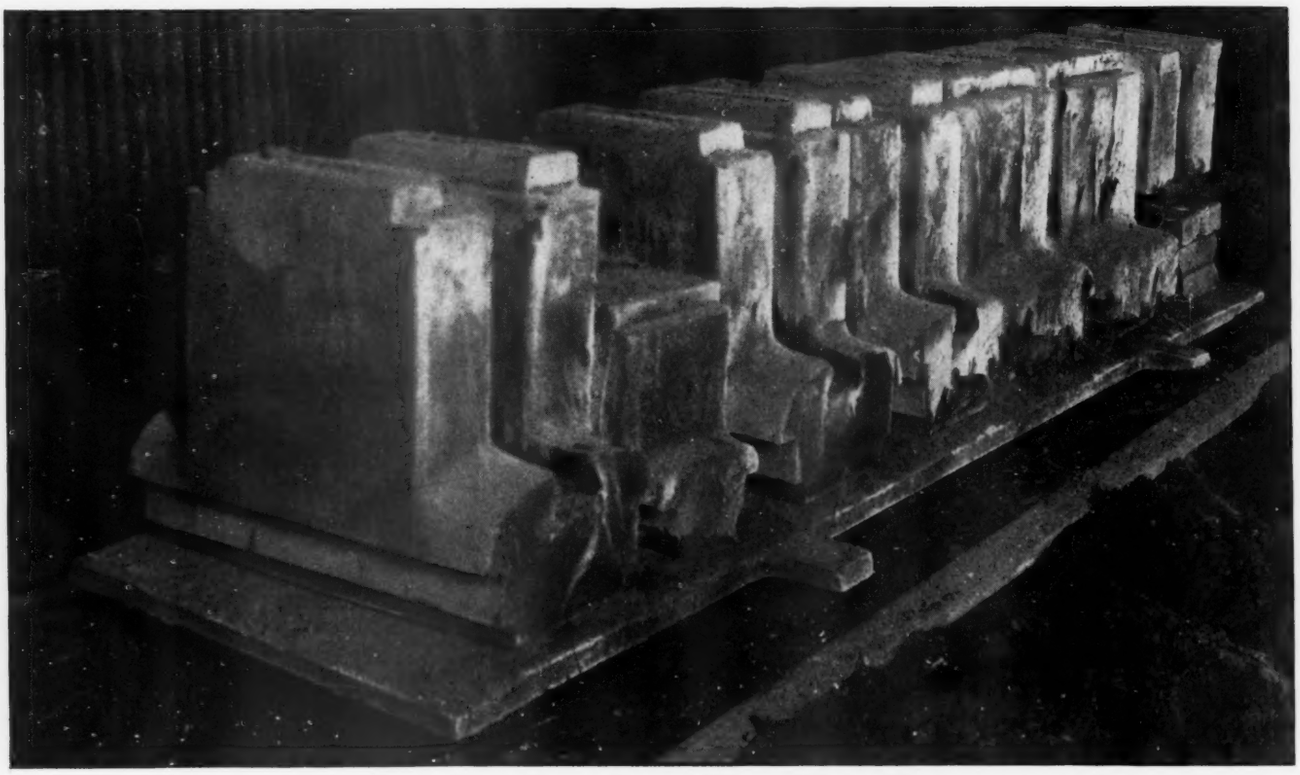


FIG. 6—SET OF MAIN CORES FOR THE MOLD SHOWN IN FIG. 5—THE CORE WHICH FORMS THE RACK IS MADE IN SECTIONS AND INSERTED IN THE DOVE-TAILED OPENING SHOWN AT *A*. ONE SECTION TO EACH CORE—THESE SECTIONS ARE MADE A CLOSE FIT AND NEED NO FURTHER SECURING

pits in the floor supplemented by frames either of wood or iron which serve the double purpose of guides to set the pattern by and also obviate the necessity of digging the pit so far below the surface of the floor. In some cases bottom boards are employed and by using two or more frames the whole mold is kept above the floor level and therefore in a more convenient position for pouring. In all cases weights are employed to hold down the copes and transverse clamps having long toes are used to prevent the sides of the frames from swelling out due to the pressure of the molten metal. An assembled mold showing most of these features is shown in Fig. 2.

The wooden frames are made of substantial lumber 6 inches in thickness, held together by ¾ or 1-inch bolts at the ends.

The copes are provided with from 6 to 8 handles depending on their length, to equalize and distribute the weight when they are being lifted off and on. These long flasks are never taken out of the shop. When not in use on the floor they are stacked on brackets attached to the columns carrying the crane runway. A number of flasks thus piled may be seen in the illustration in Fig. 1.

The molds for the lathe beds are made in green sand which is afterward skin-dried with natural gas, burned in perforated iron pipes fitted in various lengths and shapes adapted to the length and width of the molds in which they are to be used. The burners are set on a few bricks on the bottom of the mold and the open top of the mold is covered over with sheets of corrugated iron. One of these single burners in a finished mold is shown in Fig. 3. The gaggers on the joint are used to support light rods which in turn carry the weight of the corrugated iron sheets.

Lathe Ways Are Chilled

Practically all of the patterns are made adjustable in length by providing the end core of the set with stop off thickness pieces. One of these cores is shown in the far end of the mold illustrated in Fig. 3. To make one of these molds an excavation is made sufficiently deep to bring the top surface of the pattern flush with the edge of the frame generally used in making molds of this character. A level bed is prepared on the bottom of the excavation on which the pattern is lowered. Short cast iron chills are slipped in under the shoulder of the pattern until they come in contact with the core print which extends the full length of the pattern down the center. These chills are tucked firmly into place and then sand is rammed around the pattern in the usual way until the top is reached when the parting is made and the pattern drawn. The cope is not rammed until after the mold is cored.

The average size and shape of the chills used on the lathe ways may be

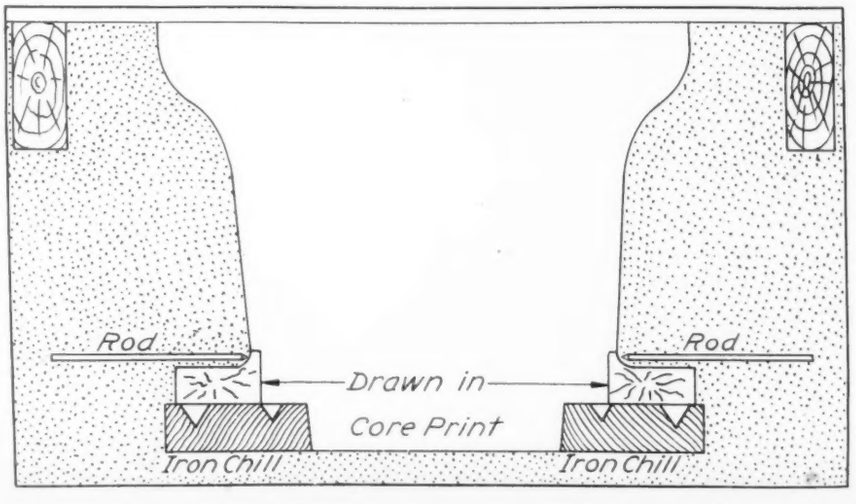


FIG. 7—SECTION SHOWING DETAIL OF LOWER SHOULDER AND CHILLS

seen in Fig. 1, where two of them are shown resting on one of the binder bars. The lower shoulder of the pattern is made separately from the rest and remains in the mold when the main pattern is drawn out. It is then drawn into the mold horizontally in sections. The V-shaped ways in the mold are not made by the pattern. That feature is cared for by the chills. The lower shoulder of the pattern is flat on the bottom as shown in Fig. 7, and therefore can be drawn in readily after the main pattern has been removed. Although they are known as chills these small slabs of iron do not *chill* the ways of the lathe as chilling is usually understood. Their function is to cool the comparatively heavy body of iron in that section of the casting so that contraction may take place uniformly and thus prevent distortion or springing at the ends. They also serve to close the grain of the iron on those parts of the casting which are subjected to wear in the finished machine.

Castings up to 15 feet usually are poured from one end. For those over that length, it is customary to employ two ladles, one at each end, and in extreme lengths of from 30 to 40 feet the metal is introduced at each end and the middle from three ladles. In the castings that are poured from one end the gates are formed through the body of the core which acts as a stop-off at the end. After all the cores have been set, two long gate sticks are located outside the stop-off core with their lower ends covering the gates. Sand is then rammed around them, after which the space between the core and the stop-off bar in the frame is rammed up firmly. An empty cope is then set on, filled with sand and rammed, after which the binders, weights and runner box are set on and the mold made ready for the iron.

Foundry Equipment Men Want Export Trade

Members of the Foundry Equipment Manufacturers' association held their annual meeting in New York on March 10 and 11. The first day was devoted to group meetings of the molding machine manufacturers, the sand blasting equipment makers, and other special groups, while the same day was occupied by discussion of plans for developing export demand for foundry equipment through the Foundry Equipment Export Corp. which recently was formed under the Webb act.

V. E. Minich, president of the association, acted as toastmaster at the annual banquet. His report outlined the history of the association, whose membership embraces at the present time practically all of the important interests in the field. He stated that, among other things, the association conducts a credit exchange, to which all members report delinquent accounts. These, in turn, are reported to the other members by the secretary. Mr. Minich outlined the various other lines along which information is being or will be interchanged. He also referred to the work of the publicity committee, which will issue pocket binders to important officials and department heads who buy or are responsible for the use and upkeep of foundry equipment. Bulletins containing valuable information with reference to foundry equipment, will be mailed periodically to the holders of these pocket binders.

The principal speaker at the banquet on the night of the 11th was Dr. Herbert Adams Gibbons, now of the *Century Magazine*, who served as war correspondent during the war, and as foreign correspondent for some 20 years before the war. Dr. Gibbons analyzed the various factors affecting the peace treaty and the league of nations, and emphatically favored the rejection of the treaty unless proper reservations are made to safeguard the interests of the United States. He condemned the treaty as being impossible of fulfillment, and he said that our entrance into the league of nations would be equivalent to giving an undertaking that we would guarantee the colonial possessions of European and other countries. He pointed out that although Americans do not care who will be the ultimate owners of the former colonial possessions of Germany, it is vitally necessary that in agreeing to their transfer under the domain of another flag, we insist, in behalf of our future export trade, that American goods be admitted on the same terms as the products of other countries.

A. I. Findley, editor of the *Iron Age*, spoke on conditions as he found them recently while traveling in Europe. London presented a prosperous appearance but it seemed to be based upon inflation. Americans who went to England to sell products made in this country were disappointed in most cases, although there were exceptions. The English government appointed committees during the war to investigate the prospects for competition after the war, but the exhaustive reports of these committees are not being perused. It has been found that there is an under-production of all kinds of commodities and that competition for the present is a negligible factor. Steel manufacturers in England are much disturbed by the labor situation and by the cost of fuel. He said that after the armistice, there was a feeling among English steelmakers that they would like to make arrangements with the American steelmakers in foreign trade. This was due to the realization that their chief competition in selling iron and steel abroad would come from the United States. However, this desire for an agreement in export trade did not meet with any response here. Mr. Findley said that the French, and particularly the French iron and steelmakers, expected at the time of the armistice to be put back on their feet by the help of the United States and the failure of this expectation to materialize has caused a great disappointment. The attitude of the French with respect to purchasing materials from Germany is reflected in a purchase of machinery recently made by a French interest. It accepted bids from English and American makers and then questioned the government as to whether it should take bids from German makers. The government replied affirmatively, with the result that bids were received from German companies at about one-fourth of the average American and English figures. On taking the matter up with the government, the French buyer was told to buy in the cheapest market. Mr. Findlay said that a bad situation prevailed in Germany and he spoke of a price of 2008 marks per ton prevailing on light sheets on last advices.

A. O. Backert, editor of THE FOUNDRY, and secretary of the Foundry Equipment Manufacturers' association, made a brief address.

The following officers were elected to head the association for the coming year: V. E. Minich, American Foundry Equipment Co., New York, president; Franklin G. Smith, Osborn Mfg. Co., Cleveland, vice president; A. O. Backert, Penton Publishing Co., Cleveland, secretary-treasurer; T. W. Pangborn, Pangborn Corp., Hagerstown, Md., director for three-year term.

Powow Mfg. Buys Two Plants

The Powow Mfg. Co., Amesbury, Mass., has purchased the plants of Baker Foundry & Machine Co. and the Amesbury Lamp & Plating Co., both of Amesbury, Mass., and will engage in the production and finishing of castings, fixtures and accessories for automobile bodies, as well as the operation of a general brass and aluminum foundry and machine shop. Officers of the new company are: President, Henry Miller; vice president, Edmund K. Arnold, and treasurer, James H. Walker, all of Amesbury, Mass.

THE FOUNDRY

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Metallurgical Work Curtailed

MOST foundries have little or no opportunity to do research work in the metallurgical field. Even had they such an opportunity, there would be a great duplication of work if each foundry were to delve independently into general metallurgical problems. This fact has caused the banding together of at least two great divisions of the foundry industry doing similar lines of work to carry on investigations to solve difficulties which they all meet at times in their individual shops. Even with the facilities and personnel at the command of these large associations there are phases of their work which it is not practical for them to investigate fully. In such cases they find ready to help them an organization at Washington supported by the government which has a highly trained corps of experts in every branch of metallurgy. This government research body handles problems that are too big or too difficult for technical bodies to work out economically for themselves. This large organization which has been built up from a small beginning, as its services were demanded from a broadening clientel, is the bureau of standards. At present it is studying molding sand, with a committee of the American Foundrymen's association acting in an advisory capacity. It also is making an investigation in the interests of the association of Manufacturers of Chilled Car Wheels to determine the effects of the different elements on iron. Such an investigation is of great value not only to the foundrymen but to the railroads and to every person who is dependent on the country's carriers.

The work of the bureau of standards is threatened by the cry of governmental economy which is so loudly voiced at Washington. A bill has passed the house curtailing the work of the bureau. The statutory positions of chemist, which is held by the chief of the section of chemical metallurgy, and of physicist, held by the chief of the section of microscopy and structure of metals, are to be abolished. Further, a number of appropriations for metallurgical work are to be discontinued. The main consideration in such a bill should not be primarily one of previous economy, but rather the probable effect on the personnel of the organization which sees two men who have spent years building up a section discharged and the work of the section discontinued. This, too, when these same men could now command double their government salary in private work. Service in the government's scientific departments should mean assured employment so long as satisfactory work is produced by the employe. The loss to the industries of the country through the dismissal of these men should be accounted. After an employe has built up a department in scientific development and worked along a certain line for a number of years, he acquires a fund of knowledge which makes him invaluable in his position. This store of scientific experience the government will lose by turning away these two men. It also will feel the effects on the morale of those remaining in the bureau of standards. To make this department of the highest value, able men should be retained at the head of each division, and if changes must be made it would be better to make them among the men in less responsible positions. In this way, the bureau would act as a training school for young metallurgists, chemists and physicists, and at the same time be kept up to the highest standard of accuracy and usefulness. It certainly is not good policy to surrender any of the ground gained.

Trade Outlook in the Foundry Industry

EARLY spring finds the castings industry overwhelmed with business and with a strong sellers' market prevailing. Practically in no section of the country is it possible to buy castings unless old established connections form an incentive to some foundries to make exceptional efforts to meet manufacturers' requirements. Despite the additional foundry capacity which has been provided in the past year, and the great amount which has become available through expansion of existing facilities, a serious shortage exists particularly in gray iron and malleable castings.

No Reaction in Sight

The past two weeks has been marked by strenuous efforts on the part of many large manufacturers of automobiles to secure castings from foundries within the district comprised by Illinois, Michigan, Ohio, Indiana, Pennsylvania and western New York. Some requiring several hundred cylinder blocks per day have been endeavoring to place even 10 or 15 a day with small shops, seeking thus to make up the total number needed. One inquiry for several thousand single cylinder motor castings, wanted by a foreign manufacturer aroused no interest in the section which at present is unable to handle current business on various classes of automobile work. Malleable foundries, also, are unable to meet the unprecedented demand for their products. It is stated that the malleable shops have orders on their books which in many cases would require nine months to complete without any more being added. Some of these foundries anticipated a slackening off in the demand for automobile castings, through the inability of manufacturers to secure other commodities which enter into the cars, bringing a consequent limiting of production. However, this prediction not only has proved unfounded up to the present, but the reverse effect is noted. Shortage in materials has prompted many manufacturers to order beyond estimated needs to secure a proportion of the castings which they will require. Production in malleable plants is limited to about 60 per cent of capacity due to labor shortage.

Railroads Buying

Railway buying is developing slowly. Inquiries in the western car building centers indicated that upward of 30,000 box cars will be placed in the near future. In the East, locomotive works are active due to heavy buying both from American and foreign lines. In the great majority of instances, steel shops which depend almost entirely upon railway work are again in operation. Malleable plants specializing in railroad castings are refusing other less desirable contracts in the expectation of early and heavy railway requirements. Difficulty in placing car business is the result of two factors, namely troubles in financing and in securing adequate supplies of steel and other materials required. Further, the cost of construction has mounted until box cars which formerly cost about $800 are now over $3500 each.

Prices Advance

Casting prices are advancing, forced upward by the rise in all materials and the labor which enters into their production. Cast iron pipe recently was advanced $2 per ton, which brings the New York quotation to $75.30 per ton for 4-inch sizes. Stove prices are higher by 20 per cent than they were last year, and 125 per cent above prewar levels. The demand for stoves, ranges and furnaces was never more keen. It is stated that the capacity of practically all makers is engaged until July 1 at prevailing prices and no contracts are made after that date except at prices governing at the time of delivery. The price question no longer concerns the jobbers and dealers who buy all classes of heating, plumbing and sanitary equipment. The ability of the manufacturer to produce and delivery is the sole basis of new contracts. With the great excess of demand over supply, foundries are enabled to select the class of work best suited to their facilities. Although some are so fortunate as to have pig iron on their yards which was purchased as low as $27 a ton, castings prices in general are adjusted on a scale which has present pig iron quotations as a basis. The justice of this method for computing estimates is unquestioned, as foundries will have to absorb the difference in price on a falling iron market. Raw material prices show but little variation over the past two weeks. The general tendency is to stabilize on present quotations which range from around 40 for No. 2 foundry at Birmingham to $44 for Pennslyvania furnace iron.

Prices of Raw Materials for Foundry Use

CORRECTED TO MARCH 25

Iron		Scrap	
No. 2 foundry, Valley	$42.00 to 43.00	Heavy melting steel, Valley	$26.50 to 27.00
No. 2 foundry, Birmingham	40.00 to 42.00	Heavy melting steel, Pittsburgh	27.00 to 28.00
No. 2 foundry, Chicago	42.00 to 45.00	Heavy melting steel, Chicago	25.00 to 26.25
No. 2 foundry, Philadelphia	45.90 to 47.35	Stove plate, Chicago	34.50 to 35.00
Basic, Valley	43.00	No. 1 cast, Chicago	42.75 to 43.25
Malleable, Chicago	43.56	No. 1 cast, Philadelphia	40.00 to 41.00
Malleable, Buffalo	46.25	No. 1 cast, Birmingham	30.00 to 32.00
Coke		Car wheels, iron, Pittsburgh	41.00 to 42.00
Connellsville foundry coke	$7.00	Car wheels, iron, Chicago	38.00 to 38.50
Wise county foundry coke	8.25	Railroad malleable, Chicago	33.00 to 33.50
		Agricultural malleable, Chicago	32.00 to 32.50

The merchant stack tonnage report for February indicated approximately 4,775,000 tons of unfilled orders booked. Basing an estimate upon the February production of slightly over 600,000 tons, the normal merchant iron capacity of the country is engaged until Nov. 1. These figures tend to explain the slackening off in buying, and also, in a measure, support the statements of pig iron producers that this fall and winter will see a shortage of iron. Coke has been procured with difficulty during the past two weeks. Coming into effect April 1, the government price restrictions will be removed. With coke at present bringing $7 to $10 a ton, consistent with prevailing coal prices, a further advance is not expected.

New York quotations on nonferrous metals follow: Copper, 18.50c; lead, 9.00c; tin, 59.75c; antimony, 10.62½c to 10.75c; aluminum, No. 12 alloy, producers' price 31.50c, and open market, 30.00c to 31.00c. Zinc is 8.45c to 8.50c, St. Louis.

Comings and Goings of Foundrymen

HENRY F. BLUMENAUER has resigned as sales manager of the Naugatuck works of the Eastern Malleable Iron Co., to become vice president and general manager of the Arcade Malleable Iron Co., Worcester, Mass. Mr. Blumenauer graduated from Andover in 1907 and from Cornell university in 1911. He spent some time with the Standard Oil Co., at Calcutta, India, becoming assistant manager of the Calcutta branch. On his return to this country he entered the services of the Eastern Malleable Iron Co., serving as sales manager at the Naugatuck plant for three years.

F. Wilson now represents the Western Crucible Steel Casting Co., Minneapolis, at Duluth.

Donald Payne resigned recently as assistant production manager of the Aluminum Manufacturers, Inc., Cleveland, to become advertising manager for the Osborn Mfg. Co., that city.

Lyman P. Hubbell of the Fillmore Avenue Foundry & Iron Works, Buffalo, was elected president of the Employers' association of that city, recently.

L. W. DeWitt, formerly of the Chicago works of the National Malleable Castings Co., Cleveland, has been transferred to the Washington office of that company, succeeding the late Charles Bieder.

K. Kennedy, a mechanic with a wide experience, has established a pattern shop at Anniston, Ala., which will be devoted exclusively to the making of patterns for the various pipe plants and foundries in that city.

Fred Rodgers formerly foreman with the Setz Mfg. Co., Crown Point, Ind., has accepted the position of assistant superintendent with the Green Fuel Economizer Co., Beacon, New York.

At a meeting of the directors of the Aetna Foundry & Machine Co., Warren, O., M. I. Arms II was elected president and treasurer; M. C. Boyd, secretary; and V. E. Rehr, vice president and general manager.

H. B. Dineen has been appointed trade manager of the Moline Plow Co., Moline, Ill. He went with the Moline Plow Co. last fall as assistant production manager. He formerly was assistant trade manager and manager of the plow works of Deere & Co.

James Rigby Jr., previously in the importing and exporting business, has become associated with the American Foundry Equipment Co., New York and Chicago, to take charge of sales in the New York office.

H. B. Schwartz, metallurgical engineer for the National Malleable Castings Co., Indianapolis, gave a public lecture on "Malleable Iron" at the Worcester Polytechnic institute, Worcester, Mass., March 19.

Henry Payne, for some time metallurgist with the National Malleable Castings Co., has been transferred from Sharon, Pa., to the Cleveland works. He will have charge of special research work.

Thomas E. Malone, secretary of the J. S. McCormick Co., Pittsburgh, foundry equipment, who has been seriously ill has gone south to remain for several months for recuperation.

John D. Capron, of the Chicago sales office of the United States Cast Iron Pipe & Foundry Co., has been transferred to the company's offices at Burlington, N. J., where he will fill the position of publicity manager.

R. L. Baldwin, formerly in the heroult electric furnace department of the United States Steel Corp., New York, recently severed this connection, to become manager of sales of the Republic Carbon Co., Niagara Falls, New York.

Wm. V. Crayne formerly connected with the Lima Metals Co., Lima, O., is now operating a brass foundry in Massillon, Ohio, in company with C. H. Noble. They do a general jobbing business in brass and aluminum castings, including patterns and pattern plates.

John H. Black has severed his connection with the Biehl Iron Works, Inc., Reading, Pa., and has been succeeded by Herbert N. Bell as president. R. C. Laros for many years engineer with the Easton Car & Construction, Easton, Pa., is now a member of the staff of the Biehl Iron Works, Inc.

Clifford B. Connelley, state commissioner of labor and industry, was the speaker at the regular monthly meeting of the Pittsburgh Foundrymen's association held March 16. He explained the organization of the department and the workings of the various bureaus, touching especially upon those handling labor disputes and compensation.

Ray T. Middleton has resigned as general sales manager of the Standard Steel Castings Co., Cleveland, to become vice president and director of sales and advertising for the Kelly Metals Co., Chicago, Detroit and Los Angeles. Mr. Middleton's headquarters will be Chicago, where the Kelly company, at an early date, will establish its principal production plant. The company will continue its present plants in Detroit and Los Angeles and later establish a third branch plant, at a point to be selected in the east.

F. J. Ryan, general manager of the American Metallurgical Corp., Philadelphia, and a member of the Philadelphia Foundrymen's association, addressed the latter society at the March meeting. His subject was "Core Ovens Heated by Electricity, and Low Temperature Work in Electric Core Ovens." The talk was illustrated by a number of lantern slides. He compared the electric core oven with those using coke, coal, gas or oil.

Emil F. Axner, who has been in charge of merchant pig iron sales for the Illinois Steel Co. at Chicago ever since the company began selling pig iron to foundries, has resigned and will engage in business on his own account. Mr. Axner entered the employment of the Illinois Steel Co. when a boy. After the Tennessee Coal, Iron & Railroad Co. was taken over by the United States Steel Corp. he handled sales of pig iron in the Chicago district for that company also.

Association Prepares for Columbus Meeting.

The annual conventions of the American Foundrymen's association and the metals or nonferrous division of the American Institute of Mining and Metallurgical Engineers, will be held jointly in Columbus, O., during the week of Oct. 4, 1920. An extensive exhibit of foundry and machine shop equipment, tools and supplies will be held in connection therewith at the same time and place. The exhibits will be housed in the buildings

Outlines the Future of Steel Castings

Col. A. E. White, consulting metallurgical engineer, University of Michigan, Ann Arbor, Mich., addressed the regular weekly meeting of the Cleveland Engineering society, Tuesday, March 9, taking for his subject the future of steel castings. The speaker stated that while in the inspection service during the war, many manufacturers of steel castings complained that the government specifications were too severe and preferred not to accept orders rather than try to meet them. He deplored this attitude and claimed that the only way for any industry to achieve success was by a constant striving to reach and maintain higher standards of manufacturing excellence.

Heat treating or annealing, as it is commonly called, the most important feature in connection with the production of steel castings met with a remarkable apathy on the part of the average steel foundryman. The remarkable success in standardization of product reached by the malleable iron manufacturers in recent years was quoted to show what could be done along the same lines in the manufacture of steel castings. The speaker stated that better results could be secured if foundries specialized more and did not attempt to handle such a widely diversified variety of castings. In conclusion he made a plea for closer co-operation between the designer and the foundry superintendent pointing out that many casting losses are due entirely to faulty design.

Frederick E. Gordon, Sand Producer, Is Dead

Frederick E. Gordon, who died at his home in Conneaut, O., March 12, was prominently identified with various phases of the foundry industry for the past 40 years. Mr. Gordon was born in Cleveland, July 10, 1856. In the early seventies he became connected with the *Cleveland Herald*, but gave up this position to enter the shop of the Taylor & Boggis Foundry Co. where he later became superintendent. After serving 17 years continuously with the Cleveland foundry, he left, in March, 1890, to take up the position of superintendent for the Fuel, Gas & Electric Engineering Co., Pittsburgh, which later was taken over by the Westinghouse Electric & Mfg. Co. He was with this company for three years during which time he bought sand from the Conneaut territory and became interested in several holdings in that vicinity. He resigned his position with the Pittsburgh foundry to become president and manager of the Ohio Sand Co. Later when the Interstate Sand Co. was formed in Cleveland, he became vice president, and when the Ohio Sand Co. was merged into the Gordon Sand Co., Conneaut, O., Mr. Gordon headed the new consolidation. He continued in charge of the company's operations until his death.

FREDERICK E. GORDON

BENJAMIN D. FULLER, past president of the American Foundrymen's association and now representing the interests of the W. D. Uptegraff Co., Pittsburgh, in Niagara Falls, N. Y., was a lifelong friend of Mr. Gordon, whom he characterizes as follows:

In the death of Fred E. Gordon, president of the Gordon Sand Co., Conneaut, O., there has passed one whose name and face were familiar to many hundreds of foundrymen, particularly the foundrymen of the middle section of the country. Mr. Gordon, by reason of his genial manner and wholesome energy, ever was a welcome visitor, and who by constant personal supervision was enabled to realize ideals in business, inspiring confidence and gaining for himself steadfast friends. As a producer of molding sand he soon became a recognized leader in the business. Mr. Gordon will be missed, not only by business associates but by the many friends who have enjoyed the hospitality of his fine home in Conneaut and by members of the American Foundrymen's association, of which body he was an active member and whose annual meetings he attended regularly.

Mr. Gordon possessed a scientific interest in foundry practice. He was keenly awake to the possibilities of betterment through experimentation, and by his own investigations he developed facings for light, fine castings. He was recognized as one of the most able and conscientious producers of high grade molding sands.

Despite his business activities, Mr. Gordon was prominently identified with the community affairs of his home town. He was a member of a number of fraternal orders, and also of the Colonial and Old Colony club. At the time of his death he was president of the Citizens Banking & Trust Co. of Conneaut. He is survived by his wife, Cordelia M. Gordon, and two daughters, Mrs. Arthur S. Barrows, Chicago, and Mrs. Morgan C. Newell, Cleveland.

Obituary

Charles A. Weeks, the inventor of the Weeks rotating electric furnace for nonferrous metals, died at his residence in Philadelphia, Feb. 21. Mr. Weeks' entire life was spent in connection with scientific developments, mostly in the improvement of metals and furnaces.

Frank H. Clement, who was active in foundry affairs in Rochester, N. Y., died at his home in that city, March 18. Mr. Clement was president of the Erie Foundry Co., and chief of construction for the American Woodworking Machinery Co., both of Rochester. Mr. Clement was born on a farm near Rochester in 1843. He was graduated from the Parma academy and also at the Rochester Collegiate institute. He learned the trade of machinist and soon became a foreman. Later, he formed a partnership with T. L. Turner, to manufacture woodworking machinery. This business developed into the Frank H. Clement Co., of which Mr. Clement was president. In 1897 the company was merged with the American Woodworking Machine Co.

William H. Frost, president of the Smith's Falls Malleable Casting Co., Ontario, Canada, died on March 18, at the age of 72 years.

Charles A. Bieder, assistant manager of sales of railways, of the National Malleable Castings Co., died in Cleveland, March 13. Although a young man, about 35, Mr. Bieder discharged important duties for his company and had represented it for seven or eight years in Washington in its relations with railways in the southeastern states and in Cuba and had built up a considerable business in that time.

of the Ohio state exposition grounds which are located within the city limits, a 15-minute car ride from the leading hotels. Four street car lines will afford transportation facilities. Railroad switches and unloading facilities are available along the side entrance to the grounds. The buildings are constructed of brick, steel and concrete and are all provided with concrete floors with the exception of the arena which has a dirt floor. Water, gas and electric current are available and these together with other facilities will make possible a more complete and extensively operated exhibit than ever before.

The 1920 exhibition committee is made up as follows: C. S. Koch, president, A. F. A., Fort Pitt Steel Casting Co., McKeesport, Pa., chairman; W. R. Bean, vice president, A. F. A., Eastern Malleable Iron Works, Naugatuck, Conn.; H. R. Atwater, Osborn Mfg. Co., Cleveland; S. T. Johnston, S. Obermayer Co., Chicago; V. E. Minich, American Foundry Equipment Co., New York; J. B. Pero, 1216 Boatmen's Bank building, St. Louis; J. S. McCormick, J. S. McCormick Co., Pittsburgh; Thomas W. Pangborn, Pangborn Corp., Hagerstown, Md.

Develops New Type Rotary Sandblast Barrel

A new sand blast barrel has been developed by Fred Washburn, J. R. Sheldon and C. A. Dreisbach and is now manufactured by the Standard Equipment Co., New Haven, Conn., of which Mr. Dreisbach is president. This equipment was designed for cleaning small castings by sandblasting while rotating them to insure a constant change of position. A feature of the new barrel is the elimination of hoppers, manifolds or other projections extending into the interior of the drum itself, which, of course, provides an increased capacity for castings. The blast is obtained through nozzles mounted in four iron boxes or chambers which are fastened to the outside of the barrel at the four 90-degree points. One of these is shown in the illustration, Fig. 1. This box also forms a cover which is designed to permit ready access for inspection or replacement of nozzles. In addition to forming a support for the nozzles the chamber mentioned also forms a sand pocket or box of such design that, as the barrel revolves and brings each one of the four, successively, to the lowest point, abrasive material enters through the holes shown. This abrasive material, during the time the chamber is in the upper position, can only escape out through the nozzles.

The cycle of operation is briefly as follows: The barrel revolves continuously and slowly in one direction. As each sand chamber with its set of nozzles reaches a predetermined point near the top of its revolution, air is injected through a timing valve. This drives the abrasive out through the nozzles and causes the grit to play across the top of the castings contained in the barrel. As the set of operating nozzles passes through the upper portion (about 90 degrees) of its travel, the chamber which is diametrically opposite is filling up with the spent abrasive which has fallen to the bottom of the barrel. The blast continues through one set of nozzles until the next set has reached the point where air is admitted to its chamber. Air is shut off from the descending set at approximately the same time as it is turned on to the ascending box and the blast is therefore continuous across the top of the castings. The cycle may be considered as divided into four parts, each a quarter of a revolution. The upper quarter is the blast, the lower is the filling period and the intermediate quarters are idle travel periods between these two operations.

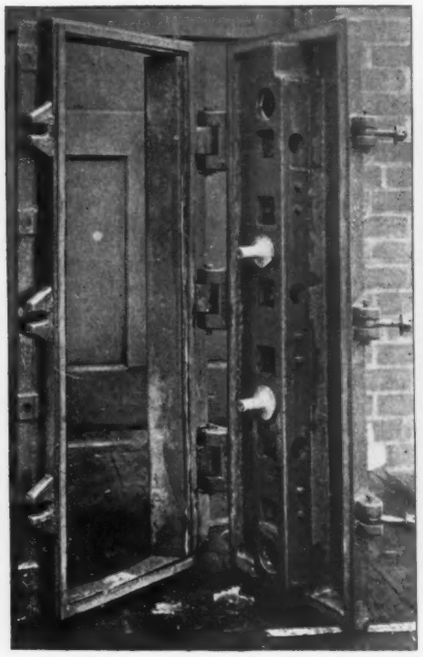
As may be observed the sand is used repeatedly, merely passing from the blast down through the castings within, to the bottom of the barrel and from there it falls into the blast chamber and is carried up to the blast again. However, the air which is used in the blast must have some place to escape and must not take sand with it. This is effected through a separator which is shown at the back of the barrel in the illustration.

Pointers for the Cleaning Room Foreman

(*Concluded from Page* 265)

reduce the speed of a small diameter wheel by pressure. The most common wheel diameters used for snagging large castings are 18 and 20 inches for swing frames and 20 to 24 inches on floor stands.

It is recommended that snagging wheels be run at a surface speed of



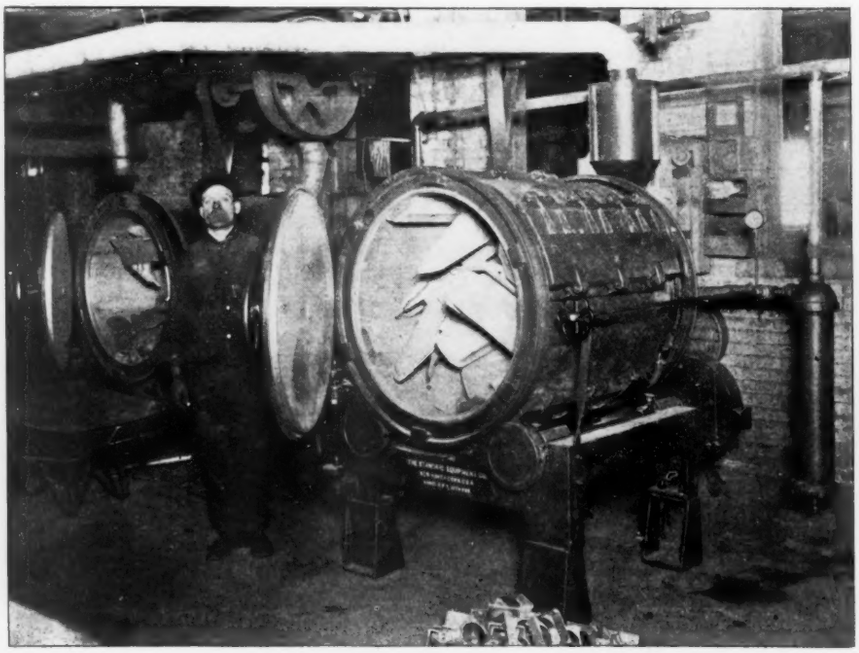


FIG. 1—BLAST BOX OR CHAMBER WITH NOZZLES THROUGH WHICH THE ABRASIVE IS FORCED INTO THE BARREL. FIG. 2—COMPLETE SANDBLAST BARREL SHOWING THE FOUR BLAST CHAMBERS AND THE CONNECTING SEPARATOR

5000 to 6000 feet per minute. To keep production, the wheel must run at a uniform surface speed to maintain a constant production. To remove a certain amount of material, a certain amount of energy must be expended. This energy is stored in the abrasive grains and the amount in each grain depends upon the speed. Since this energy varies as the square of the surface speed, a reduction in wheel speed results in a much larger reduction of energy available for removing material in a number of grains. Such a condition can be bettered and practically eliminated by using a variable speed motor or by using cone pulleys so that the speed may be increased as the wheel wears. If only one speed is possible on the machine change the wheels to a machine that has a higher rotative speed.

The personal factor is important in the grinding room. Carelessness adds greatly to wheel wear. On a swing frame grinder, the machine may be tipped so that grinding is done on the corner of the wheel. There may be a large number of weights on the machine arm. An operator may "bang" the wheel on the casting or carelessly run into projections or heavy fins. Corners are knocked off the wheels with no resultant increase in producwheel wear. Careless dressing is often a cause of excessive wheel wear. This feature of the work should be attended to by a man who is competent to perform the duty.

To Use Akron Laboratory

Arrangements have been made between the Courtney-Fraser Co., of New York, and the Charles C. Kawin Co., of Chicago, whereby the laboratory of the former at Akron, O., will be operated as a branch of the Charles C. Kawin Co. The Courtney-Fraser Co. has arranged to have the business of its laboratory at Buffalo cared for at the Buffalo laboratory of the Charles C. Kawin Co. Both Mr. Courtney and Mr. Fraser have retired from all connection with the company.

Acquires New Foundry

The Flint Foundry Co., Flint, Mich., has acquired the foundry formerly occupied by the Marshall Castings Co., Marshall, Mich., and will operate it as the Flint Foundry Co., a branch of the Flint, Michigan plant. Automobile work will be made exclusively. J. M. Barringer is president.

Holyoke Foundry Takes Over McHugh Works

The Holyoke Foundry Co., Holyoke, Mass., has taken over the McHugh Foundry Co. in that city. A. J. Britton, recently superintendent of the Capitol Foundry Co., Hartford, Conn., is vice president and general manager, and Harry M. Lee of the Bond Engineering Works, Toronto, Can., treasurer and in charge of the business management. The foundry is rented from the Holyoke Heater Co., which recently purchased it from John P. McHugh, Edward T. McHugh and Charles H. House. The occupants of the building will be the Holyoke Heater Co., the Holyoke Foundry Co. and C. H. House, formerly of the McHugh Foundry Co., who will operate a machine shop.

Crude Oil Imports Sets Up a New Record

In January the United States imported 6,293,353 barrels (of 42 gallons each) of crude petroleum, and 626 from other countries, making a grand total of imports of 6,293,979 barrels, says the federal geological survey. Exports to Canada in January totaled 421,618 barrels and to other countries, 7068 barrels, or a total of 428,686 barrels. The excess of imports over exports in January thus was 5,865,293 barrels. In December, 1919, the excess of imports over exports was 3,319,870 barrels, and in January, 1919, 3,560,380 barrels.

The merchandise business of Marden, Orth & Hastings Corp. and the M. O. H. Oil Products Co., New York, has been combined and will be conducted under the name of Marden, Orth & Hastings Co., Inc. Marden, Orth & Hastings Corp. simultaneously changed its name to the Industrial Ownership Corp. and will control the stock of subsidariy companies.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

The Bostick Stove Co., Lapeer, Mich., has increased its capital from $50,000 to $75,000.

The Regent Brass Foundry Co., Marysville, O., has increased its capital from $15,000 to $100,000.

The Decatur Castings Co., Decatur, Ind, will open a plant.

The foundry owned by M. J. A. Desjardins, Rigaud, Que., recently was damaged by fire.

The Penn Foundry & Mfg. Co., Reading, Pa., has increased its capital from $25,000 to $35,000.

The Goodman Engine & Machine Co., Pittsburgh, plans the erection of a machine and pattern shop.

The North Lebanon Foundry Co., Hazelton, Pa., has increased its capital from $10,000 to $60,000.

The plant of the Elmwood Castings Co., Elmwood, Cincinnati, O., recently was daamged by fire.

The Vincennes Foundry & Machine Co., Vincennes, Ind., will build a new plant, 80 x 150 feet.

The Iowa Machine Works, Clinton, Iowa, contemplates the erection of a foundry, 130 x 160 feet.

Erection of a foundry is contemplated by the Edwin Pratt Sons Co., 118 West Court street, Kankakee, Ill.

The International Molding Machine Co., 2654 West Sixteenth street, Chicago, has let a contract for the erection of a plant addition, 40 x 88 feet.

The Lynchburg Foundry Co., Lynchburg, Va., plans to erect an addition to its plant.

The Cambria Car & Foundry Co., Johnstown, Pa., has increased its capital from $50,000 to $100,000.

J. W. Akin, Stanwood, Wash., plans to erect a foundry and machine shop, the main structure to be 50 x 100 feet.

The Lion Products Corp., La Crosse, Wis., R. Pieper, manager, Funk building, will build a foundry, 100 x 150 feet.

Erection of an addition to its foundry, 72 x 320 feet, is contemplated by the Tulsa Stove & Foundry Co., Sand Springs, Okla.

The Deschler Foundry & Machine Co., Toledo, O., recently was chartered with $25,000 capital, by R. T. Garrison, E. S. Ammon and others.

The Dolve Valve Co., 208 Wells street, Chicago, has awarded a contract for the erection of a plant, 100 x 123 feet.

The Keystone Foundry Co., Plymouth, Ind., has awarded contracts for the erection of a plant addition.

Capitalized at $300,000, the Fremont Foundry Co., Fremont, O., recently was chartered by E. H. Bailey, G. H. Engler, A. Lieber, F. G. Jones and A. L. Hunt.

Bids have closed for a 65 x 75-foot plant addition to the Waterbury Pattern & Model Co., Waterbury, Conn.

The Monitor Stove & Range Co., Cincinnati, has purchased a site on which it is reported planning the erection of a plant.

The H. J. Frank Foundry & Machinery Co., Davenport, Iowa, is erecting a foundry building, 80 x 100 feet, with cupola house, 40 x 40 feet.

The plant of the Copper Clad Malleable Range Co., St. Louis, recently was damaged by fire. It will be rebuilt.

The American Manganese Bronze Co., Philadelphia, plans the erection of a foundry addition, 24 x 60 feet.

The Atlas Brass Foundry Co., Columbus, O., has had plans drawn for the erection of a foundry, 84 x 100 feet.

The Elmira Foundry Co., Main and Woodlawn avenue, Elmira, N. Y., contemplates the erection of a plant, 119 x 560 feet.

The United States Hoffman Machine Co., Syracuse, N. Y., plans the erection of a foundry building.

The Powelson Foundry & Machine Co., Rochester, N. Y., has been incorporated with $200,000 capital.

by J. W. Powelson, F. C. Kimmel and H. J. O'Brien.

The Sowers Mfg. Co., Buffalo, is building an addition to its foundry and machine shop.

The Tarrant Foundry Co., West Grand avenue, Chicago, has had plans prepared for the erection of a storage building.

The Lufkin Foundry & Machine Co., Lufkin, Tex., recently increased its capital from $149,500 to $200,000.

An addition, 45 x 75 feet, will be built to the brass foundry of the Lake Mills, Wis, plant of the Creamery Package Mfg. Co., of Chicago.

The A. & J. Mfg. Co., Gadsden, Ala., will establish a plant for the manufacture of stoves. A building, 80 x 504 feet, will be erected.

The Jackson Foundry Co., Jackson, Mich., will erect a building, 100 x 140 feet. George Dugot is president.

B. Dillon, 43 King street, Brockville, Ont., has been appointed architect and is preparing plans for a foundry for Machinery & Foundries, Ltd.

J. Fleury's Sons, Wellington street, Aurora, Ont., will start work soon on the erection of a molding shop.

The Aluminum Castings Co. has been incorporated at Indianapolis, with $1,000,000 capital, by H. C. Smith, W. R. Macy and W. H. Breeden.

The Eagle Foundry Co., Tenth and Liberty streets, Muncie, Ind., has had plans prepared for the erection of a foundry, 150 x 200 feet.

The Sargent & Greenleaf Co., Rochester, N. Y., has started work on the erection of a foundry building, 40 x 130 feet.

The capital stock of the Oglesby Furnace Stove Co., Clinton, Ind., recently was increased from $50,000 to $100,000.

The Riverside Foundry & Machine Co., Great Falls, Mont., has been organized by Andrew H. MacLean, Charles H. Small, O. J. Grendreau and others, with $100,000 capital.

The Grand Rapids Piston Ring Co., Grand Rapids, Mich., has been incorporated to manufacture piston rings and castings, with $30,000 capital, by George O. Burchard and others.

The Canada Electric Castings, Ltd., Orillia, Ont., has been incorporated to manufacture iron, steel castings, etc., with $40,000 capital, by Burnett C. Lamble, James B. Tudhope and others.

Adam Clark, Ltd., Hamilton, Ont., has been incorporated to manufacture stoves, furnaces, etc., with $250,000 capital, by William J. Clark, Alfred T. Harvey and others.

The plant and equipment of the Maisonneuve Foundry, 860 LaSalle street, Montreal, Que., has been purchased by Burnett & Crompton, who will continue to operate the plant.

The Burlington Brass Works, Burlington, Wis., is having plans prepared for the erection of a foundry and shop addition, 92 x 144 feet. C. R. McCanna is president of the company.

Capitalized at $50,000, the Xenia Foundry & Machine Co., Xenia, O., recently was incorporated by W. M. Huston, C. J. Held, W. F. Held, E. Peater and H. G. Sohn.

The Shreve Foundry Co., Shreve, O., recently was incorporated with $40,000 capital, by J. H. Sowash, T. C. Bottomly, D. S. Freeman, A. F. Greter and P. Hutt.

Architect Albert Anis, 139 North Clark street, Chicago, is preparing plans for the erection of a foundry, 100 x 250 feet. The name of the owner has been withheld.

The Tait-Marston Engineering Co., Boston, has been incorporated to operate a foundry and machine shop, with $50,000 capital, by W. E. Tait, William M. Marston and Thomas Lithgow.

The National Malleable Castings Co., Sharon, Pa., has acquired the building of the Aschman Steel Casting Co., and is replacing it with a larger and more modern structure.

The Moncrief Furnace & Mfg. Co., Guelph, Ont., recently was incorporated to manufacture furnaces, etc., with $50,000 capital by Elmo S. Moncrief, Cleveland, Wellington J. Shibley, John R. Howitt and others.

The Independent Steel Specialties Corp., Ltd., Montreal, Que., has been incorporated to manufacture iron, steel, castings, etc., with $250,000 capital, by William L. Davies, A. A. Gowan and Frank P. Turville.

The Pocock Mfg. Co., Ltd., Hamilton, Ont., has been incorporated to manufacture iron, castings, etc., with $100,000 capital, by S. J. Pocock, George Hope and Thomas B. McQueston.

The Dominion Conduit Co., Montreal, Que., has been incorporated to manufacture iron, steel, castings, etc., with $300,000 capital, by William Johnson, Robert Mills, Richard C. Simmons and others.

The Ideal Valve Co, Detroit, has been incorporated with $30,000 capital, by H. M. Groomes, 425 Church street, and others, to manufacture valves and brass products.

The Emerson-Brantingham Co., Rockford, Ill., Charles S. Brantingham, president, is converting one of its gray iron foundries into a malleable foundry and will erect some additions.

The Cribben & Sexton Co., stove manufacturer, 680 North Sacramento avenue, Chicago, has let a contract for the erection of a plant addition, 70 x 120 feet.

Capitalized at $50,000, the Brightwood Brass Foundry, Inc., Springfield, Mass., recently was chartered by Jacob Magaziner, Isidor Satin and Joseph Satin, West Springfield, Mass.

Capitalized at $25,000, the Eastman Mfg. Co., Manitowoc, Wis., recently was incorporated to manufacture brass and bronze appliances, by H. L. Eastman and others.

Incorporation papers were recently filed for the Holyoke Foundry Co., Holyoke, Mass. The company, which is capitalized at $60,000, was chartered by K. A. Bowler, Springfield, Mass., Harry A. Lee and Frank J. O'Neil.

The Emery Steel Castings Co., Baltimore, which recently was reincorporated and took over the property of the Emery Steel Co., has purchased a building which will be remodeled into a steel foundry. An electric furnace will be installed.

The Hubbell Mfg. Co., Ltd., Toronto, Ont., has been incorporated to manufacture stoves, etc., with $40,000 capital, by M. G. Hubbell, George P. McHugh, room 207, 72 Queen street; Carl M. Herlick, 2 Maughan Crescent, and others.

The Kilby Pipe & Foundry Co., Birmingham, Ala., has filed papers of incorporation with $30,000 capital. Officers are E. M. Kilby, president; R. E. Yolton, vice president, and H. W. Bostick, secretary and treasurer.

The Indiana Foundry Co., Muncie, Ind., is erecting a foundry, 150 x 200 feet, to have a capacity of 50 tons a day, and is in the market for molding machines, industrial trucks and small equipment and supplies. H. D. Hartley and H. B. Harvey are the owners of the company.

The Sherbrooke Iron Works, Sherbrooke, Que., has been acquired by George L. Dourne and F. A. Schaff, New York, who will continue to operate under the name, Sherbrooke Iron Works. Machinery will be installed for the manufacture of locomotives, marine and stationary superheating apparatus, and steam specialties. In addition the company will continue to carry on a general foundry and machine shop business.

Cupola, blowers, grinders and a monorail system are being inquired for by the Canton Pattern & Mfg. Co., Canton, O., which company recently was incorporated with $100,000 capital. It plans to erect a plant for the manufacture of gray iron castings. Officers are: President and treasurer, T. M. Dobs and secretary and general manager, E. W. Starkey. The company's office is at 920 Market street, Canton.

The Etowah Foundry & Machine Co., Gadsden, Ala., which was recently organized by W. T. Murphree, Evan J. Owen and C. P. Butcher, has purchased a fully equipped foundry and is prepared to manufacture iron, brass and copper castings. The company is planning to build and equip a modern machine shop, and equipment for this extension as well as some additional foundry equipment will be needed.

The Cook-Lewis Foundry Co., Greensboro, N. C., recently sold its plant, and now has under construction a new plant, the main building to be 40 x 75 feet, exclusive of core room, casting sheds, pattern storage, etc. The core room and casting sheds will adjoin the main structure. The company at present is located in temporary quarters. Officers of the company, which is capitalized at $50,000, are A. R. Lewis, president; E. J. Lewis, vice president, and C. H. Lewis, secretary and treasurer.

Capitalized at $300,000, the Premier Warm Air Heater Co. has been organized at Dowagiac, Mich., and a site has been secured on which a large plant will be erected. The contract for the construction of the first building has been let. This will be 120 x 360 feet. An all cast iron heater of an improved type will be manufactured. Officers of the company are: President, William F. Judd; vice president and general manager, Harry L. Wood; superintendent, Ralph S. McNaney; secretary, C. C. Sinclair and treasurer, Richard M. Judd. These men, with William M. Cory and E. Bruce Laing, compose the board of directors.

New Trade Publications

PORTABLE HOIST.—A cardboard folder is being circulated by the Canton Foundry & Machine Co., Canton, O., in which the work which can be performed by a portable crane and hoist is described.

CUPOLAS.—The Whiting Foundry Equipment Co., Harvey, Ill., has published a booklet containing a list of the users of cupolas which it has manufactured. According to the booklet, the company has had cupolas on the market for the past 35 years, and up to date, about 3500 have been installed.

CRUCIBLES.—The importance of keeping and handling crucibles in a manner which will insure the greatest number of heats with the least danger of accidents, is emphasized in a booklet entitled, "Crucibles—Their Care and Use," which was recently published by the Joseph Dixon Crucible Co., Jersey City, N. J.

INDUSTRIAL RELATIONS.—The Norton Co., Worcester, Mass., has published a booklet containing a number of reprints of papers, prepared by heads of the company's various departments, which briefly outline the service, employment, medical, safety, recreation, co-operative gardening and housing activities of the company for its employes.

CRANES.—A booklet has been published by the Whiting Foundry Equipment Co., Harvey, Ill., in which electric traveling cranes, bucket handling cranes, gantry cranes, transfer cranes, handpower cranes, jib cranes, pillar cranes, bucket cranes and various cranes accessories and parts are described and illustrated. The booklet is profusely illustrated showing the various cranes in actual operation.

FIREBRICK CEMENT.—The McPhee Cement Co., Scranton, Pa., has published a 4-page leaflet in which cement for bonding firebrick and kindred uses is described. According to the leaflet this cement is air and gas tight and has the same coefficient of expansion and contraction as firebrick. The leaflet further states that it sets at normal temperature and holds its strength up to 3000 degrees Fahr. Other details are given.

WELDING EQUIPMENT.—Welding and cutting torches, regulators, preheating outfits, etc., are described and illustrated in a booklet recently published by the Messer Welding Supply Corp., Brooklyn, N. Y. The welding torch is of the injector type and works on the low pressure or vacuum principle. It has seven interchangeable heads with hard copper heads and necks. The cutting torch also operates on the injector principle, and the torch head is so constructed that the preheating flame entirely surrounds the concentrated cutting jet. Besides describing the equipment, the booklet contains instructions for setting up and using welding outfits.